SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1912.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

OCTOBER 1912.

GENERAL PHYSICS.

1476. *Apparatus for Harmonic Analysis and Synthesis.* **E. W. Brown.** (Roy. Astronom. Soc., M.N. 72. pp. 454–468, April, 1912.)—In the computations for the expressions for the moon's place some mechanical device for dealing with the large number of small harmonic terms has long been needed. The problem consists of two stages: (*a*) the arrangement of large masses of numbers which have to be added in different ways; (*b*) the actual addition of these numbers. The second part is quite satisfactorily solved by the comptometer. For the first arrangement a system of tapes carrying cards is carried by a frame with a controlling grille, and a bar for moving all the tapes the space of one card at a time. Examples are given of various uses of the model. C. P. B.

1477. *Simple Viscometer for very Viscous Liquids.* **G. F. C. Searle.** (Cambridge Phil. Soc., Proc. 16. pp. 600–606, July 24, 1912.)—Description and illustration of apparatus of the immersed rotating drum type, with results obtained for treacle. At 12·8° C. the viscosity of black treacle is found to be about 400, and that of water about 0·0146 c.g.s. units. L. H. W.

1478. *Friction.* **J. Andrade.** (Comptes Rendus, 155. pp. 201–203, July 16, 1912.)—Describes an extremely accurate method of determining coefficients of friction. The method is based on the well-known principle that if a body, turning about an axis, under the influence of a simple pendular force, is also acted on by friction of constant moment, the body will maintain its sinusoidal vibrations, but the null-point of these is displaced from one side to the other of the null-point of the pendular force, in such a way that the semi-amplitudes decrease, as long as the motion lasts, in arithmetic progression. The wheel pendulum used by the author was capable of oscillating for more than 4 hours, and was subject to friction of constant pressure N, whose intensity was sufficient to stop the motion of the pendulum in 3 or 4 vibrations, *i.e.*, at the end of about 9 or 12 seconds. Neglecting at first the small irregularity of the pendular force, the resistance of the knife-edge and that of the air, we get the relation $u_0 - u_n = 2nN\rho f/MgL$, where MgL is the max. moment of the weight on the wheel pendulum, $fN\rho$ the moment of the friction, acting at a distance ρ from the knife-edge, f being the coefficient of friction, u_0 and u_n the absolute values of the semi-amplitudes of the first and the $(n + 1)$th simple oscillation. Details are given of the method by which f may be determined from this formula. Corrections for irregularities of pendular force, &c., are easy to make, and an accuracy of 1 in 8000 may be reached without difficulty. A. W.

1479. *Changes in Leaf Metals as a Result of Surface Tensions during Heating.* **H. Schottky.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 480–488, 1912.)—The author has made experiments on the effect of heating leaf metals (0·087 to 2·9 μ in thickness) at temperatures up to 970° C. Gold leaf (97 per cent. Au, 3 per cent. Cu) becomes wrinkled at 350–400° C. and shrinks markedly between 440° and 500° C. In air and oxygen silver leaf first becomes wrinkled and then transparent owing to the formation of a network of holes only visible under a magnification of 180 diams. Finally it falls to a mass of glistening scales. The temperatures of the various changes increase with increasing thickness. In hydrogen and nitrogen the changes take place at much higher temperatures, but no powdering occurs even at 800° C. Copper behaves like silver in oxygen-free atmospheres, while even at 600° C. Al only develops a microscopic surface roughness. To explain these phenomena the existence of surface tensions in the crystal elements counteracting the forces of orientation is assumed. The latter forces diminish more rapidly as the temperature rises, with the result that they are ultimately overcome, when a deformation of thin metal layers is to be expected owing to contraction of the crystalline lamellæ. In silver, solution of oxygen brings about either a diminution of strength or an increase in the surface tension. Experiments made with a view of determining the magnitude of the surface tension showed that the ultimate strength per mm.^{2} of thin sheets is less than that of thicker sheets, which can be partially traced to the fact that the effect of surface tension in thin foils manifests itself by reducing the strength. It is therefore maintained that in mechanically-deformed metals surface tensions are so concentrated as to bring about recrystallisation in proportion to their magnitude.

F. C. A. H. L.

1480. *Changes in Dimensions of a Steel Wire when Twisted, and Pressure of Distortional Waves in Steel.* **J. H. Poynting.** (Roy. Soc., Proc. Ser. A. 86. pp. 534–561, June 27, 1912.)—A previous account has been given [Abstract No. 1668 (1909)] of experiments showing that wires when twisted lengthen by an amount proportional to the square of the angle of twist, a result expected from an analysis of the strains in a finite pure shear. In those experiments considerable loads were used. The present paper describes experiments in which both the change in diam. and the longitudinal extension on twisting a wire were measured; the change in diam. is also proportional to the square of the angle of twist. The change is sensibly the same for large loads and the smallest that could be used, when the wire was sufficiently straightened before being twisted, so that apparently the only function of the load is to straighten the wire. To measure the change in diam. the wire was fastened at the bottom of a long narrow tube filled with water. It passed out from the top of the tube through a water-tight leather washer. A vertical capillary glass tube was sealed into the side of the tube, and the change of the water-level in the capillary indicated the change in volume of the twisted wire within the tube. Theory of the changes of dimension is given, also a mathematical discussion of the pressure in the direction of propagation in distorsional waves, and the longitudinal waves produced by the pressure. A. W.

1481. *Influence of the Width on Notched Impact-test Specimens.* **R. Baumann.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1811–1814, Aug. 17, 1912. Communication from the Materialprüfungsanstalt d. Kgl. Techn. Hochschule, Stuttgart.)—It is often found that the impact test, though of undoubted value if properly applied, gives evidence of brittleness in contradiction to the other tests. In the tests described the specimens were of the same width as thickness and the notch extended to the middle of the section. In the case of a boiler plate 34 mm. thick, pieces were cut 34 mm. and 8 mm. wide, and the energy in kg.-metres per sq. cm. to produce fracture was 5·4 and 10·8 respectively. Annealing reduced the former to 2·5 but increased the latter to 10·8. Specimens of widths varying from 0·5 to 8 mm. were tested from wrought-iron rods 40 mm. diam. and 80 mm. and 40 mm. square. The two former were all treated in a hardening bath of sodium and barium chlorides. Then half were annealed by immediately placing in carbon to cool; the rest were left in the bath after hardening before being annealed, and are described as "heat treated." In all cases heat treatment more than doubles the energy capacity of the material. The round rod shows no definite variation of energy per sq. cm. with varying widths, whether annealed or heat-treated. For the 80 mm. square rod, annealed, the energy shows little variation from 0·5 to 2 mm. width; it then falls sharply by over 50 per cent. and continues to fall. The heat-treated specimens give very erratic results with no definite law of variation perceptible; the material was very tough and fibrous and allowed the hammer to pass by bending sideways. The specimens of 40-mm. square rod were all annealed; they all show a sudden fall of energy above 1·5 to 1·8 mm. The narrow specimens appear at the fracture to be tough, and the contraction of area is considerable, but the wider ones show a brittle fracture with very little contraction. The suggested explanation is that the interruption by the notch of elastic flow and lateral contraction causes the greater part of the energy capacity of the material to be used in a narrow specimen, whereas only a small proportion is effective with a wider section. This was confirmed by specimens in which the section at the notch was still further reduced by drilling holes from the under face to the bottom of the groove. The energy used was increased threefold. The heat-treated specimens show less variation with the section because the process promotes a tough fibrous formation. Tests on cast iron show that the energy per sq. cm. absorbed increases with the initial kinetic energy of the hammer, the reason being that, with a brittle material, the broken halves absorb a relatively large amount of energy in accelerating. This must be allowed for in deducing results of tests on a brittle material, but is negligible with a ductile material. In conclusion the author suggests that the official 8 mm.-wide test-piece should be reduced in width. E. J. S.

1482. *Tensile Strength of Rods with a Portion turned down.* **R. Baumann.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1814–1816, Aug. 17, 1912. Communication from the Materialprüfungsanstalt d. Kgl. Techn. Hochschule, Stuttgart.) —Kirkaldy and Bach have shown that a forged rod which has a portion of its length turned to a smaller diam. has an ultimate strength, reckoned on the smallest initial area, which increases as the turned portion becomes shorter. The reason is that the elastic flow and accompanying lateral contraction are retarded by the contiguity of the wider and therefore stronger part. This paper describes tests made with the object of evaluating the change of the ultimate stress. It is found that the ultimate strength rises very rapidly when the length *l* of the turned-down part becomes less than the diam. *d*. This increase for any one ratio of *l*/*d* becomes faster as the ratio D/*d* is increased, where D is the larger diam. of the rod. These relations are expressed in the formula $z = D/(d + 1) . a/[(l/d)^2 + 0{\cdot}1]$, where z = percentage increase of ultimate stress over that of a uniform rod, and *a* is a quantity which, for the material tested, varies from 8·5 to 5. The process of failure is of interest. A photograph shows that the outer portion of the small section fails at one end before the max. load is reached, partly detaching a ring of triangular section. During and after this period the material in the wider part flows through the ring, retarding the ultimate breakdown and forming a central core in the fracture. The local contraction is seen in a specimen with very short turned-down portion to have extended appreciably into the wider part.

E. J. S.

1483. *Reduction of Stress through Filleting Sharp Corners.* **E. Preuss.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1849–1855, Aug. 24, 1912. Communication from the Materialprüfungsanstalt, Darmstadt.)—The test-pieces were 90°-angles of annealed steel plate with the inside angles respectively sharp and filleted with radii of 15 mm. and 85 mm. Three sets were tested, of widths 18·8, 26·6, and 40 mm. By means of an optical extensometer apparatus, the strain distribution was plotted along the bisector of the right-angle, due to a tensile load applied, perpendicular to the bisector, at a point in each arm. A very sharp maximum strain (or stress) occurs at the inside of the angle, but rounding with radii of 15 mm. and 85 mm. reduces it by 76 % and 84 % respectively for 40 mm. width of arm. With narrower arms, 18·3 mm., the reductions are 86 % and 92·5 %. The observed max. stresses are compared with theoretical maxima computed by three methods: (1) By considering the load as producing a combined direct stress and bending stress on the section along the bisector—a common assumption. (2) By using the theory of curved beams, the outer angle being assumed to be rounded from the same centre as the inner. (8) Similar to (2) but the outer angle rounded with same radius as the inner. Method (8) is a nearer approximation than (2), and both are nearer than (1), that commonly used. For the sharp angle the observed max. stress is independent of the width of plate, and equals 9·1 times the result of method (1). For the rounded angles the proportion is about 2¼, and shows small variation with the radius of fillet and width of plate. The conclusion is drawn that, within the relatively wide limits of the tests, the stress at the edge of the fillet may be taken as approximately 2¼ times that calculated by method (1). The observed neutral axis lies nearer the inside than theory (1) suggests, the discrepancy being 24 %, 18·2 %, and 14 % of the length along the bisector, with the respective fillet radii of 0 mm., 15 mm., and 85 mm. The position as calculated by theory (2) agrees very closely with that observed. In this calculation amounts equal to 87 % and 44 % of the section are cut off by rounding the outer angle and are neglected. The inclusion of these parts would throw the neutral axis further away from the inside as in case (1). The author suggests that the displacement of the neutral axis, implying that only part of the section is effective in bearing stresses, accounts for the very high maximum at the inner edge.

The reason is that the lines of equal stress in the metal tend to set themselves as nearly straight as possible. This is borne out by maps of equal stress, obtained by making observations along lines parallel to the bisector. The extensometer used gave a large magnification optically, the datum length being 8·8 mm. The length was reduced to 0·7 mm. in order to approximate to a rectilinear datum at the edge. A special apparatus was devised to give an adequate magnification in the latter case. E. J. S.

1484. *Nutation in Practical Applications of Gyro-action.* **B. L. Newkirk.** (Phys. Rev. 35. pp. 27–30, July, 1912.)—In theoretical discussions of gyro-action, a couple may be supposed applied suddenly. But in the practical application of gyroscopes it is important to note that, owing to the non-rigidity of the materials, a couple cannot be applied instantly. The present paper treats the problem when the couple increases from zero at a certain rate. The solutions show that the amplitude of nutation will be much less than the value corresponding to sudden application of the disturbing couple. The expression for the amplitude of the nutation when the load is applied gradually contains in the denominator the angular velocity ω (of the gyrostat) raised to a power one unit higher than that occurring in the corresponding expression under the supposition of instantaneous application of the disturbing force. E. H. B.

1485. *Velocity of Sea Waves.* **T. Terada.** (Mathematico-Physical Soc., Tōkyō, Proc. 6. 17. pp. 260–265, June, 1912.)—It is well known that the velocities of seismic sea waves generally fall short of the theoretical values calculated from the depths of the parts of ocean traversed by the waves. Rudzki suggested the existence of a group-velocity, but gave no concrete explanation. Nagaoka treated the influence of the curvature of the earth on waves propagated on its surface, and showed that curvature decreased the velocity. The present paper gives a calculation based upon the supposed yielding of the earth's crust, which is imagined to be elastic and resting on a fluid magma (although it is admitted that Love argues against such an assumption in his "Some Problems of Geodynamics"). In this way a decreased velocity may be accounted for. Also it is pointed out that an increased velocity may be explained as that of group-waves where the distance was great enough to permit of their development. E. H. B.

1486. *Forced Vibrations.* **J. P. Dalton.** (Nature, 89. pp. 528–529, July 25, 1912.)—J. Perry has discussed the equation $(D^2 + 2kD + n^2)x = A \cos pt$, with special reference to the critical case of maximum amplitude of the forced vibration; he shows that in all the cases examined the critical value of p which excites the maximum response is either n or $\sqrt{n^2 - 2k^2}$, while the frequency of the free damped vibration is given by $\sqrt{n^2 - k^2}$. He concludes that the usual statement that "the forcing influence ought to be in tune with the natural frequency of the system" is incorrect. The present author explains the theory more fully by several neat geometrical theorems. A. R

1487. *Examination of Glass Plates for Parallelism.* **M. Schultz.** (Zeitschr. Instrumentenk. 32. pp. 258–261, Aug., 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—An interference method of examining the planeness and parallelism of glass plates is described. P. E. S.

1488. *Theory of a New Form of the Chamber Crank Chain.* **H. S. Hele-Shaw.** (Roy. Soc., Proc. Ser. A. 87. pp. 62–69, July 26, 1912.)—Gives the theory of the mechanism employed in the author's rotary pump [see Abstract No. 1104B (1911)].

1489. *Theoretical Principles of Strut Design.* **H. V. Hutt.** (Engineering, 94. pp. 113–116, July 26, and pp. 146–147, Aug. 2, 1912.)

1490. *The Sun as a Fog Producer.* **J. Aitken.** (Roy. Soc. Edinburgh, Proc. 32. pp. 183–215, 1911–1912.)—The author has observed that at Falkirk on many mornings on which the air is clear before sunrise it gradually thickens later to a dense haze, while in pure country air similar changes are never noticed. As the result of observation several conclusions are arrived at with respect to this haze, of which the most important is that when the wind is light and brings moist air from an impure direction sunshine invariably destroys the clearness of the air and causes a thick haze or fog. The present paper gives the results of some experiment made with a view to determining the cause of these sun-formed fogs. From the conclusions mentioned above it seemed probable that the action of sunlight on some of the impurities in the air caused the formation of nuclei and that these nuclei possessed an affinity for water, as the fogs were formed even on days when the air was not completely saturated. For carrying out the experiments an apparatus was used which enabled the effect of sunlight on different gases to be tested readily. A full account of this apparatus and of the difficulties met with is given in the paper. The first impurities to be tested were the sulphur oxides SO_2 and H_2SO_4. It was found that a mixture of SO_2 and pure air, while kept in the dark, had no tendency to produce nuclei, but after being acted on by light, especially by sunshine, it became a nucleus-producer. Some of these nuclei were found to have an affinity for water. When the SO_2 was mixed with air containing the products of imperfect combustion the facility with which nuclei were produced by sunning was considerably increased. It seemed probable that the CO of imperfect combustion was the partner in the formation of nuclei. Some experiments made with the normal products of combustion showed that they acted in a very similar way to the artificially-produced SO_2. From a consideration of the amount of coal burnt annually in the British Isles it is shown that there would be ample impurities produced to account for all the observed sun-formed fogs. Attention is called to the fact that the present crusade against smoke production will do nothing to stop these fogs. They have their origin in invisible impurities produced by combustion. The author points out in conclusion that he has in the present work dealt only with the effects of the products of burning sulphur, but that evidently there is a possibility of some of the other gases produced during combustion playing some part in the production of these fogs.

J. S. Di.

1491. *The Psychrometric Formula.* **E. F. J. Love** and **G. Smeal.** (Roy. Soc. Victoria, Proc. 24. 2. pp. 201–220, 1911.)—The paper deals with a modification of the normal formula $x = f - AB(t - t')$ proposed by Ekholm [see Abstract No. 988 (1909)]. This consists in the insertion of a coefficient η before the term f, so that the formula becomes $x = \eta f - AB(t - t')$ where $\eta < 1$. Different values were given by Ekholm for η, according to the material employed for the covering of the wet bulb, these ranging from 0·974 for linen to 0·918 for cotton. The authors of the present paper state that the theoretical grounds upon which Ekholm based his insertion of this coefficient appeared to them to be very slight, and they were therefore led to undertake this work with a view to determining whether Ekholm's modification or the original formula gave the most satisfactory results in practice. They point out that the apparent diminution of f in the observations discussed by Ekholm may have been due to a failure to comply with the conditions requisite for accurate use of the pyschrometer. In order to be able to obtain satisfactory readings of several thermometers simultaneously a large screen was constructed, containing a movable seat for the observer and a movable staging to hold the thermometers. The observer always placed himself to the leeward of the instruments to avoid any unequal heating effect from his body. After some preliminary work an accurate series of observations was carried out, using three wet-bulb thermometers coated respectively with silk, linen, and cotton. A Regnault condensation hygrometer was employed as standard, Broch's tables being used for vapour pressures. In 68 comparative readings the mean difference between the linen- and cotton-covered thermometers was 0·007° C., that is, it was quite negligible. Owing to an accident to the thermometer covered with silk only 11 readings could be used from this, but the results again showed no appreciable difference from the linen-covered instrument. These results are quite opposed to those of Ekholm. Applying Ekholm's formula to the observations the value of η (obtained by the method of least squares) was found to be 0·9974, or indistinguishable from unity to the order of accuracy which can be obtained in such observations.

J. S. Di.

1492. *Daily Variation of Temperature in Tripoli.* **F. Eredia.** (Accad. Lincei, Atti, 21. pp. 58–65, July 14, 1912.)—Each month is divided into three periods of about 10 days, and the average temperature for each period, taken every 2 hours, is recorded, and the results plotted on curves. In Jan. the lowest temperature occurs at 8 a.m., increasing gradually up till 2 p.m., and then decreasing; in Feb., March, and April, the minimum occurs at 6 a.m., in May and June at 4 a.m., in July between 4 and 6 a.m., from Aug. to Nov. at 6 a.m., and in Dec. at 8 a.m. The mean maximum is at 2 p.m., except in July, when it is at 4 p.m. W. H. Si.

1493. *Radiation Records obtained in* 1911 *at South Kensington; Comparison with Absolute Observations made at Kew.* **R. Corless.** (Meteorological Office, Geophysical Memoirs, No. 4. pp. 57–61, 1912.)—The observations at South Kensington were taken with a radiation recorder of the Callendar type, the receiver of which was placed on the roof of the Meteorological Office. The receiver consists of a small horizontal plate mounted inside a sealed glass bulb, and furnished with two Pt resistance wires coiled upon its surface. One of these wires is left bright, while the other is coated with a special black preparation. The difference of temperature of the two wires is recorded continuously by an electrical recorder, and a measure is thus furnished of the intensity of the radiation falling upon the blackened wire. It is pointed out that the wires being in a horizontal plane, only the vertical component of the radiation is measured. On cloudless days the pen rises steadily, with but slight fluctuations, from sunrise to a maximum at noon, and then falls again to sunset. During the night the curve is frequently a straight line, but sometimes minor fluctuations occur towards the negative side. Three figures are given illustrating typical curves. A comparison between the South Kensington values and those obtained from an Ångström instrument at Kew Observatory shows good agreement between the two sets of figures. J. S. Di.

1494. *Effect of the Labrador Current upon the Surface Temperature of the North Atlantic, and of the Surface Temperature upon Air Temperature and Pressure over the British Isles.* **M. W. C. Hepworth.** (Meteorological Office, Geophysical Memoirs, No. 1. pp. 3–10, 1912.)—It is the purpose of this paper to trace out the effect of the Labrador Current (1) directly upon the temperature of the waters of the North Atlantic, and (2) indirectly upon the air temperature and barometric pressure at certain stations on the coast of the British Isles. The amount of ice encountered by steamships crossing the North Atlantic is taken as a measure of the intensity of the current, increased activity of the current bringing down a larger amount of ice than the normal, and *vice versa*. It is found that when the increased intensity of the Labrador current deflects the Gulf Stream to the southward of its normal course temperature in the north-east arm of the Atlantic is much below the average, and pressure over the Iceland-Faroe region has a tendency to increase. The travelling depressions are then deflected to the south of their normal track. On the other hand, when the Labrador current is weakened the induced lower pressure over the Iceland-Faroe region tends to draw the passing depressions to the northward of these islands. The conditions obtaining in the years 1903–7 and in part of 1911 are discussed in detail with reference to their bearing on the above conclusions. J. S. Di.

1495. *Effect of Diurnal Rotation on Upper Atmosphere.* **C. G. Darwin.** (Phil. Mag. 23. pp. 664–668, April, 1912.)—As the earth rotates the forces of viscosity tend to drag the lower portions of the atmosphere with it, so that the mass motion of the air in this region has the same angular velocity as that of the solid earth itself. At a certain height above the adiabatic region the density becomes so small that there are practically no collisions between the molecules, and here viscosity will no longer be a determining factor. It would thus be expected that at altitudes above the collision region the mean motion of the air would lag behind that of the earth, and the present paper was undertaken to find the amount of this lag. It is also shown that the lag is counterbalanced by another effect, masking the observations directly, so that no effect is perceptible up to more than four radii from the earth's centre. C. P. B.

1496. *Earthquakes and Rainfall.* **F. de M. de Ballore.** (Comptes Rendus, 155. pp. 379–380, July 29, 1912.)—Some have conjectured that the frequency of great earthquakes might be associated with periods of dryness or wet, of heat or cold. Especially has it been suggested that megaseisms are numerous in Brückner's wet periods. The author of the present paper has investigated the great earthquakes since 1020. They show no clear variation with meteorological conditions, and they certainly do not support the above-mentioned hypothesis. A. D. R.

1497. *Earthquake of* 1911, *November* 16. **B. Galitzin.** (Comptes Rendus, 155. pp. 375–379, July 29, 1912.)—From observations made at many stations in France, Germany, Austria, and Switzerland, the author deduces the position of the seismic epicentre at latitude 48° 19′ N. and longitude 9° 28′ E., the disturbance having originated at a depth of about 9·5 km. (with a probable error of 3·8 km.). A. D. R.

1498. *Wave-length of Green Corona Line.* **A. Perot.** (Comptes Rendus, 154. pp. 1381–1383, May 20, 1912.)—During the eclipse of April 17, 1912, the green coronal ray at the west limb was observed with a spectroscope of strong dispersion. The sun's image was projected by a concave mirror on a copper plate having a rectangular slit so placed as to pass light from points 1 mm. away from the sun's limb, and an image of this slit was then projected on the spectroscope slit. Means were provided for displacing the solar image, so as to examine the spectrum of the east and west coronal regions alternately. It was only possible to observe the radiation on the western limb, where the corona line was seen to be broad, dissymmetrical, sharply defined on the violet side, and degraded towards the red. The wave-length was determined to be 5303·7, which is larger than that found by Campbell in 1898 (5303·3) [Abstract No. 456 (1900)]. C. P. B.

1499. *Illumination Variation during Solar Eclipse, April* 17, 1912. **R. Jouaust** and **P. de la Gorce.** (Soc. Int. Élect., Bull. 2. Ser. 3. pp. 333–335, May 1912.)—During the solar eclipse of April 17, 1912, which was very nearly total, measurements of the horizontal illumination were taken with a Mascart photometer. About one minute before central eclipse the illumination was of the same order as that of twilight during the last days of April, but in the intervening minute it fell to less than one-twentieth of this amount. The curve of illumination as plotted from the measures is markedly dissymmetrical with respect to the maximum phase, the increase being more rapid than the decrease. **R. Gautier.** (Archives des Sciences, 33. pp. 381–390, May, 1912.)—At the Geneva Observatory arrangements were made to obtain records of the contact times, photographs of the different phases, temperature variations, sunshine, wind and solar radiation. Reproductions of the various results are appended. Of special interest are the comparative photographs of the harbour entrance during full sunlight and at the time of mid-eclipse, showing the remarkable diminution of illumination. C. P. B.

1500. *Spectroscopic Observations during Solar Eclipse, April* 17, 1912. **A. Fowler.** (Roy. Astronom. Soc., M.N. 72. pp. 538–541 and 548, May, 1912.)—Observations were made at the Royal College of Science Observatory with a 6-in. equatorial and Evershed spectroscope. Magnitude of eclipse 0·92. The prominences were examined before the eclipse commenced, and were of the quiescent type. Thirty-five minutes before mid-eclipse many high-level lines were noted at the southern cusp, and as the eclipse proceeded the bright lines became more numerous, until the appearance became very similar to that seen during a total eclipse. About 15 minutes after maximum phase the bright lines rapidly diminished in number, and the high-level enhanced lines were last observed 35 minutes after mid-eclipse. Attention is drawn to the possibility of long-exposure photographs being possible during 70 minutes if instruments had been available. A search was made for the green corona line at mid-eclipse, but no trace of the line was seen. C. P. B.

1501. *Spectrum of Chromosphere, Solar Eclipse, April* 17, 1912. **H. F. Newall.** (Roy. Astronom. Soc., M.N. 72. pp. 536–538, May, 1912.)—The magnitude of the eclipse at Cambridge was 0·906, and as at the greatest phase the atmospheric glare in the sun's neighbourhood would be reduced to only 12 per cent. of that with full sunlight, it was considered advisable to try and photograph the flash spectrum. This was done with the Littrow spectrograph, an image of the tip of the crescent being thrown on the slit from a double cœlostat and 12-in. lens of 60 ft. focal length. On one plate the flash spectrum shows from 30 to 40 bright lines, most of which have been identified with lines in Dyson's list of eclipse chromospheric lines, certain inversions of intensity being noted. Another plate, taken just after epoch of greatest phase, shows a complicated system of emission lines and absorption lines. In some cases the bright lines were accompanied by dark companions, not represented in the ordinary Fraunhofer spectrum. The appearance suggests a possible explanation of the systematic displacements of lines attributed to different chemical elements. From the general results it is concluded that for spectroscopic work on the chromosphere most useful work could be done by the observer going outside the totality track until the magnitude of eclipse was about 0·99, as his programme could be carried out then with more leisure and completeness. C. P. B.

1502. *Kinematograph Record of Solar Eclipse, April* 17, 1912. **C. Lobo.** (Comptes Rendus, 154. pp. 1396–1399, May 28, 1912.)—Nine stations were installed in a direction normal to the central line, and a kinematograph apparatus set up at the position Lat. N = 40° 50′ 20″; Long. W. 8° 35′ 54″. The instrument was fed with light by a heliostat and objective of 7 cm. aperture, 1·14 m. focal length. About 560 images per minute were obtained, the interval between each pair being 0·11 sec. A few of the images are reproduced, showing that the place selected was practically on the central line of eclipse. It is suggested that the moon may be slightly flattened at the regions near the ends of rotation axis, and this would explain certain anomalies found in the predicted diameters; the flattening might be from 1/1800 to 1/600. C. P. B.

1503. *Spectroscopic Rotation Period of Uranus.* **P. Lowell.** (Observatory, 449. pp. 228–230, June, 1912.)—During Aug., 1911, spectrograms were taken by V. M. Slipher at the Lowell Observatory with the 24-in. refractor, the exposures being made as near the meridian culmination as possible. The slit was placed parallel to the longer axis of the satellites' apparent orbits. The resulting value for the rotation period of the planet is 10·75 hours, in a retrograde direction. C. P. B.

1504. *Nova Geminorum* (1912). (Roy. Astronom. Soc., M.N. 72. pp. 515–518, April, 1912. From Royal Observatory, Greenwich.)—From three observations with transit circle, the position of the Nova is RA = 6h. 49m. 11·85s.; Decl. = + 32° 15′ 5·6″ N. (1912). Comparison of a photograph taken with the 6-in. Franklin-Adams lens on 1912 March 15 with one on 1905 Feb. 28 confirms the observations of M. Wolf in showing that the Nova may be coincident with one of two small stars of the 15th or 16th magnitude. The photographic magnitude was determined by the interferential method, using a screen over the objective. The spectrum was photographed with a 30-degree flint prism of aperture 2½ in., placed in front of the 6-in. Franklin-Adams lens, on March 15, 19, and various following days. Drawings are given showing the lines present on the photographs of March 15 and April 3. **M. Wolf.** (Astronom. Nachr. No. 4569. Nature, 89. p. 250, May 9, 1912. Abstract.)—Remarks on the periodic changes in structure of the composite hydrogen bands in the spectra of the Nova. A period of about 7 days is suggested, which may be in some relation to the variation of similar period

found in the light-changes by Kritzinger. **C. Gallissot.** (Comptes Rendus, 154. pp. 1393–1395, May 28, 1912.)—Observations made at the Lyons Observatory with a heterochrome photometer gave the magnitudes of the star compared with neighbouring stars, chiefly θ Geminorum. Variations in colour were determined by the interposition of coloured screens. **M. Luizet.** (Ibid. pp. 1395–1396, May 28, 1912.)—Photometric observations made at Lyons Observatory by Argelander's method, using the Potsdam Catalogue for reference stars. The magnitudes are given from March 14 (8·80) to May 22 (7·55). The colour of the star on March 14 was yellowish-orange; on March 25 it became redder, and later on again more yellow.
C. P. B.

1505. *Spectrum of Nova Geminorum* (1912). **W. E. Curtis.** (Roy. Astronom. Soc., M.N. 72. pp. 511–515, April, 1912.)—Photographs were taken on March 15 with a 6-in. telescope provided with an objective prism of 12½° refracting angle, with exposures of 35 min. and 60 min. Although the scale of the spectrum is small (F–K = 6 mm.) a considerable amount of detail was shown on the plates. The spectrum comprised broad bright lines with conspicuous dark companions on the violet side. In the case of the most intense lines the maximum of intensity was appreciably displaced to the violet side, as has been previously found in Nova Aurigæ and Nova Persei. The bright lines are closely allied to those found in the solar prominences and chromosphere. Other photographs were obtained on March 28, 29, and the changes found are noted. A table of the lines measured is included, with references to lines in previous novæ.
C. P. B.

1506. *Spectrum of Nova Geminorum* (1912). **R. H. Curtiss.** (Astrophys. Journ. 35. pp. 233–236, April, 1912.)—A summary is given of observations of Nova Geminorum (1912) made at the University of Michigan Observatory at Ann Arbor, with a single-prism spectrograph. Hydrogen, helium, and calcium lines are strong and show complex structure. On March 13 the wide emission lines show evidence of slight recession, while the velocity of approach indicated by the absorption lines differs for different elements, and is quite different for helium and parhelium. The sharp reversals of the calcium lines indicate a velocity of + 5 km. ± 3 km. On March 15 the contrasts were much accentuated, and well-marked absorption lines developed at λλ4368, 4611, and 4670. Velocity from calcium reversals (H, K) increased to + 10 km. Other plates were obtained on March 16, 19, 22. After March 19 the changes were very notable. On the violet side of the absorption bands there was indication of doubling, the violet component being strongest in the case of H_β, H_γ, H_δ and H_ζ, while for the helium lines the violet component was the weaker.
C. P. B.

1507. *Spectra of Temporary Stars.* **H. Deslandres.** (Comptes Rendus, 154. pp. 1321–1327, May 20, 1912.)—Based on the daily observations of the solar atmosphere, which shows on a small scale similar phenomena to those exhibited by new stars, a new explanation of the causation of temporary stars is propounded. Depending on the extent of its atmosphere, the sun would, if removed to the distance of the stars, give indications of bright-line radiation, say in H and K lines of calcium. Now the yellow stars of solar type form about one-third of the whole stars, and it is possible that their emission radiation would be detected if instruments of sufficient dispersion were employed. Further, the reversal of the H and K lines is slightly asymmetrical. In the daily series of spectroheliograms obtained at Meudon by means of these lines, the most brilliant points are above the faculæ, and the central ray, K_3, is displaced towards the red, implying descent of the vapour. Over the dark filaments, however, the K_3 line is displaced towards the violet; the vapour is there ascending. The difference between these velocities of ascent and descent is about 8 or 4 km. per sec., but during special disturbances it may attain a value of 100 km. per sec. Imagine then a body partly solidified, with a crust relatively thin. Under the influence of various causes, this crust is broken. The interior incandescent gases, maintained until then at high pressure, will suddenly escape to the exterior, and form for a certain time a dense brilliant atmosphere, animated with movements similar to these of the solar atmosphere, but much more rapid. Presently the crust will re-solidify below this atmosphere, which will gradually cool down and lose its brilliancy. The final transformation to the nebular radiation, however, still remains without explanation. C. P. B.

1508. *Spectrum of R Cygni.* **T. E. Espin.** (Roy. Astronom. Soc., M.N. 72. pp. 546–548, May, 1912.)—Observations during Aug. and Sept., 1911, showed the magnitude at first to be about 18·5. When seen again in Oct. it was 8·7, and this increased until from Nov. 29 to Dec. 9 it was 6·8. From the spectrum observations made the type appears to be III, with very prominent green line of hydrogen (H_β). **W. H. Wright.** (Ibid. pp. 548–558, May, 1912.)—Measurements of three spectrograms of this variable bright-line star photographed with the single-prism spectrograph attached to the Lick refractor. A remarkable feature is the fading of the continuous spectrum in the blue, and the absence of the more refrangible hydrogen lines. Many of the dark lines are of exceptional breadth, indicating some form of general absorption as if by an extensive cool atmosphere. A table of wave-lengths and reproductions of the spectrum are included. C. P. B.

1509. *Gravitational View of Two-star Stream Theory.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 72. pp. 474–487, April, 1912.)—In a former paper [Abstract No. 1166 (1912)] it was pointed out that the appearance of dual convergence of stellar motions might arise from the convergence and divergence of stars visiting the gravitational centre of our system. The present note reviews the evidence available, with suggestions for further tests. C. P. B.

1510. *Atmospheric Pressure and Sun-spots.* **E. Leyst.** (Soc. Imp. Nat. Moscow, Bull. 1–3. pp. 93–158, 1911.)—Mean values of atmospheric pressure are tabulated for epochs of maximum and minimum sun-spots for Pawlowsk, Batavia, Greenwich, Potsdam, Irkutsk, the day and night amplitudes being separated, and the whole discussed harmonically. [See also Abstract No. 1505 (1910).] C. P. B.

1511. *Comparison of Stellar Magnitude Scales.* **H. H. Turner.** (Roy. Astronom. Soc., M.N. 72. pp. 464–473, April, 1912.)—The paper is in continuation of a former one [Abstract No. 999 (1909)], proposing that a comparison be made of the stellar magnitude scales of the different observatories taking part in the Astrographic Catalogue, and contains, as example of what is required, an examination of the results of the Bordeaux Catalogue, 1905. C. P. B.

LIGHT.

1512. *Cassegrain Telescope Mounting.* **E. Schær.** (Archives des Sciences, 33. pp. 201–210, March, 1912.)—After some preliminary remarks on the adjustment of telescopes in general, the author describes the construction of a large Cassegrain reflector for the observatory of Geneva during 1909–1910. The focal length is 295 cm.; diam. of large mirror 100 cm.; equivalent focal length 1760 cm. The equatorial movement is controlled by an oil clepsydra driven by a weight of 60 kg. Fittings are provided at the ocular end for employing photographic plates 18 × 18 cm. Several photographs are reproduced showing the satisfactory performance of the instrument. C. P. B.

1513. *Three-prism Stellar Spectrograph, Mount Wilson.* **W. S. Adams.** (Astrophys. Journ. 35. pp. 163–182, April, 1912.)—This instrument is the medium-dispersion spectrograph provided for use with the 60-in. reflector at the Solar Observatory, Mount Wilson, California, when the Cassegrain system is in place, the equivalent focal length of the telescope being 24·4 m. The prisms were cut from a single large one, and are 67 mm. high, 125 mm. wide. A cemented triplet of 102 cm. focus is used for the collimator, while for the camera two lenses are provided, one of 102 cm. focus, the other 46 cm. To allow of compactness in the fittings the camera is permanently arranged as for 3 prisms; when used with only one or two, a subsidiary mirror is employed in the prism train. The mounting is very heavy and rigid, and temperature control is provided giving a maximum nightly range of only 0·1–0·2° C. Guiding is by the reflecting slit method, and changes of focus are adjusted by an electric motor attached to the small convex mirror. During the past year the spectrograph has been devoted to a determination of the radial velocities of selected stars, mainly of classes A and B, of special interest with respect to star streaming. Most of them lie between magnitudes 5·5 and 6·5. A fully-timed negative of a sixth magnitude star of type G is obtained in 75 min. with slit width 0·05 mm. Details of the method of reduction are given, and a list of stars with variable radial velocities. C. P. B.

1514. *Kinematograph.* **P. Noguès.** (Comptes Rendus, 155. pp. 273–275, July 22, 1912.)—Describes a new kinematograph arrangement with which 180 images per sec. have been obtained. An improved form, now in construction, will give more than this number. For details the diagram and description in original paper should be consulted. Films obtained with this apparatus may be slowed down 20 times, and thus the mechanism of the motions photographed may be studied. A. W.

1515. *Validity of the Law of Rational Indices and Analogy between Laws of Chemistry and Crystallography.* **A. F. Rogers.** (Amer. Philosoph. Soc., Proc. 51. pp. 103–117, April–June, 1912.)—The law of rational indices limits the slopes of crystal faces to those developed by using simple multiples of the axial lengths. Faces with complex slopes are not excluded, but become rarer as the complexity is increased. This resembles that which determines the composition of chemical compounds: these are usually simple functions of the atomic weights, but larger multiples are occasionally found. T. M. L.

1516. *Absorption of Ultra-violet Light by Ozone.* **F. Krüger** and **M. Moeller**. (Phys. Zeitschr. 13. pp. 729–732, Aug. 1, 1912.)—Research on the absorption by ozone of ultra-violet light in the region 200–300 $\mu\mu$ shows that maximum absorption occurs for $\lambda = 254\ \mu\mu$. A knowledge of the absorption coefficient for a particular wave-length gives a practical method for determining the ozone-concentration of a gas mixture. Such a method is described, and it is shown that results obtained by this method are in good agreement with chemical determinations of the concentration. [See also Abstracts Nos. 760 (1910) and 339 (1911).] A. W.

1517. *Absorption of Ultra-violet Vibrations by Radio-active Elements and by their Degradation Products.* **N. D. Zelinskij.** (Acad. Sci. St. Pétersbourg, Bull. 6. pp. 465–487, April 1, 1912.)—The author's measurements of the absorption spectra of radio-active and other substances show that the activity of elements obtaining their energy from some unknown source (probably from the internal, potential energy of the atom) is exhibited in the absorption of ultra-violet light both by the active materials themselves and by their emanations. This new method of detecting the presence of radio-active substances forms the fifth now available. T. H. P.

1518. *Alkaloids and Ultra-violet Light.* **G. Michaud.** (Archives des Sciences, 33. pp. 498–499, June, 1912. Paper read before the Congrès Internat. de Photographie, Brussels, 1910.)—Thin films of silver are transparent for ultra-violet radiations of wave-lengths 3160–3260. A large number of simple and compound bodies were photographed by using a quartz lens covered with films of silver sufficiently thick to render it quite opaque to visible light. A plate is given which shows the comparative results for 24 substances obtained with quartz-silver lens and with an ordinary glass lens of the same focal length. A. E. G.

1519. *Circular Dichroism and Rotatory Dispersion of Salt Solutions.* **L. B. Olmstead.** (Phys. Rev. 35. pp. 31–46, July, 1912.)—Measurements were made of the refractive indices, extinction-coefficients, optical rotatory powers, and circular dichroism of a series of salts. Circular dichroism (*i.e.*, unequal absorption of right and left circularly polarised light, giving rise to elliptical polarisation) was observed in the tartrates, malates, and lactates of Cr, Co, Cu, and Mn; negative results were obtained with solutions of compounds containing Ni, Fe, and U. Curves are given for the four properties for 10 wave-lengths from λ4300 to 7000. T. M. L.

1520. *Polarisation of Light diffracted by Rowland Gratings.* **W. Voigt** and **P. Collet.** (Gesell. Wiss. Göttingen, Nachr., Math.-Phys. Klasse, 4. pp. 385–417, 1912.)—An extension of the Rayleigh-Voigt theory to the more general case in which the plane of incidence is inclined to the rulings of the grating. Collet's experiments show that the theory gives a fair agreement with the facts. J. M.

1521. *Study of Flicker.* **T. C. Porter.** (Roy. Soc., Proc. Ser. A. 86. pp. 495–513, June 27, 1912.)—In a previous paper [Abstract No. 209 (1903)] the author has traced out the relation between illumination and the critical speed at which flicker vanishes. It was shown that an abrupt alteration in the relation occurs when a certain low illumination is reached. It appeared that this might be due to the fact that the pupil expanded no further after this point, and flashlight photographs were taken by the author to ascertain this. But the measurements made only showed that the action of the pupil could have little influence in the matter. The author next proceeds to describe a series of experiments from which he derives curves showing the rate of growth and dying-away of the sensation of luminosity with time.

J. S. D.

1522. *Measurement of the Blackening of Photographic Plates in very Small Regions.* **P. P. Koch.** (Ann. d. Physik, 38. 8. pp. 507–522, June 18, 1912.)—Although Hartmann's microphotometers are constantly made use of for all kinds of measurements respecting photographic blackening, there are certain cases in which some slight modifications of the apparatus are necessary. Some such modifications are here described, and the methods of obtaining measurements, together with the degree of accuracy to be expected, are discussed. The results obtained are given in diagrammatic and tabular form. The application of the method for taking measurements of the distribution of blackening produced by Röntgen rays in some slit photographs obtained by Walter and Pohl is also referred to [see Abstract No. 1224 (1909)].

A. E. G.

1523. *An Optical Anomaly of Liquid Crystals in Convergent Polarised Light.* **W. Voigt.** (Deutsch. Phys. Gesell., Verh. 14. 12. pp. 649–652, June 30, 1912.)—Certain liquid-crystals which behave in a general way like uniaxial solid crystals are characterised by variations of colour in the alternate quadrants of the interference figure, which thus possesses only a twofold (instead of fourfold) axis of symmetry. This anomaly depends primarily on the pleochroism of the crystal, and not on its optical rotatory power; it can therefore be developed in substances whose optical rotatory power is too small to be detected in the thin layers available for these experiments.

T. M. L.

1524. *Electric Furnace Spectra under Pressure.* **A. S. King.** (Astrophys. Journ. 35. pp. 183–212, April, 1912.)—In a previous paper the results of preliminary experiments on electric furnace spectra under pressure were described [Abstract No. 1481 (1911)]. The investigation has been continued, and a more complete discussion is now presented, depending on the examination of about 100 negatives taken under varied conditions. The measured displacements for iron from 1–24 atmos., and for titanium and vanadium for 8 and 16 atmos. show a close proportionality between displacement and pressure. The pressure effect in absorption gives displacements which are in general of the same magnitude as for emission lines. Temperature differences of at least 500° C. show no indication of any displacement; likewise variations of quantity of vapour or length of tube show no effect. The furnace has in general given displacements much larger than those of the arc.

C. P. B.

1525. *Spectroscopic Determination of Aqueous Vapour.* **F. E. Fowle.** (Astrophys. Journ. 35. pp. 149–162, April, 1912.)—An investigation has been made of the absorption at various wave-lengths of known amounts of aqueous vapour, maintained as nearly as possible under similar conditions to the vapour existing in the atmosphere. Equivalent lengths of 128 and 245 m. were obtained by reflecting the light from intermediate mirrors in the apparatus. The observations made on the infra-red bands ϕ and ψ', cover quantities of water-vapour up to a depth of 0·5 cm. of precipitable water; beyond this limit the determinations have been extended by solar observations made on Mount Wilson, California. Although the experiments have been made only at atmospheric pressure, a computation is given which shows that the results are probably applicable with slight correction to the actual pressures at which water-vapour occurs in the atmosphere. Accordingly a method has been established by means of which the total quantity of water-vapour between the observer and the sun may be easily determined by spectro-bolometric observations. C. P. B.

1526. *Krypton and the Auroral Spectrum.* **T. W. Page.** (Phys. Soc., Proc. 24. pp. 138–140, April, 1912.)—One of the difficulties in accepting krypton as the source of the auroral spectrum is the absence of the strong krypton line λ5871·12. Observations of the krypton spectrum, using the ring discharge and canal rays, showed that the yellow and green rays persisted together under both conditions. C. P. B.

1527. *Ultimate Lines and Lines of Greatest Sensitiveness of Metals.* **A. de Gramont.** (Comptes Rendus, 155. pp. 276–278, July 22, 1912.)—A continuation of previous work [see Abstracts Nos. 1344 (1907), 321 and 1434 (1910)]. Certain sources of error which should be avoided are enumerated. The metals dealt with, Cr, Mn, Fe, Ni, and Co, were studied sometimes in mixtures, in proportions down to 1 in 100,000, sometimes fused with Na_2CO_3. (1) *Chromium.*—In salts in fusion, as well as in industrial metals, castings, steels and irons, two very characteristic triplets indicate the presence of Cr: [4289·9, 4275·0, 4254·5] in the indigo, and [3605·5, 3593·6, 3578·8] in the ultra-violet. They are of sensibility exceeding about 1 in 10,000. The lines 3605·5 and 3593·6 appear to be the ultimate rays. (2) *Manganese.*—Observed in the same saline mixtures and the same meltings as Cr, Mn appears to be much more sensitive. Two triplets also characterise it: [4034·7, 4033·2, 4031·0] in the violet, and [2605·8, 2593·8, 2576·2] in the ultra-violet. These do not belong to the two secondary series. The ultra-violet triplet persists easily to 1 part in 10,000 and gives the ultimate rays, of which the most persistent is 2576·2. The violet triplet is not much less sensitive. (3) *Iron.*—In mixtures with Zn, Cd, Al, Sn (certain lines among the following are hidden in the latter metal), the following lines can be observed to 1 part in 10,000: 4383·7, 4046·0, 3820·6, 3816·0, 3737·3, 3735·0. The two latter are the most sensitive. With a quartz spectrograph the sensitiveness is much greater; it exceeds 1 in 100,000 for the groups [2755·8, 2749·4, 2739·6], [2599·5, 2598·54], [2395·7, 2382·2]. These two last, 2382·2 especially, are extremely sensitive and appear to be the ultimate rays. Other lines exceeding 1 in 10,000 in sensitiveness are 3020·8, 2612·0, 2607·2, 2586·0. (4) *Nickel.*—More than 50 lines persist beyond 1 in 10,000 in mixtures with Pb and Zn. The most persistent are:—3858·5, 3807·3, 3619·5 (ultimate line with flint glass), 3524·7, 3515·2, 3414·9 (ultimate with crown uviol), 3038·1, 2416·2 (ultimate with quartz), 2316·1, 2303·1. (5) *Cobalt.*—Studied in mixtures with Cd and Zn, the lines of Co are relatively feebly sensitive with flint glass. The following hardly persist past 1 in 1000: 4121·5, 4118·9, 3894·2, 3845·6. With crown uviol we get also 3453·7, more sensitive than the others. With quartz the sensitiveness is very great, exceeding 1 in 10,000 for the lines 3453·7, 2663·7, 2580·3, 2420·8, 2389·0, 2378·7, 2363·9, 2311·7, 2286·2. The five last are the most persistent, 2389·0 being the ultimate line. A. W.

1528. *Series Emission from Solid Metal Compounds due to Canal Rays.* **J. Stark** and **G. Wendt.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 4. pp. 489–498, 1912. Ann. d. Physik, 38. 3. pp. 669–689, June 18, 1912.)—Many compounds of Na, Li, K, Rb, Cs, Mg, Ca, Sr, Ba, Th, Al, Zn were examined under the action of canal rays; the results are given in tabular form, and from an examination of these it appears that all elements of the group of the alkalies and alkaline earths emit from the surface of colourless compounds under the action of canal rays visible series lines. Th, Zn, and Al also have the above property, and so it appears probable that all metals emit their series lines from the surface of colourless compounds when acted upon by canal rays. The authors' results for Ca and those of Carlheim-Gyllensköld for Li and Na show that for a single metal the series emission due to canal rays is independent of the chemical nature of the compound of the metal. Negative results were obtained with many substances investigated. The latter part of the paper deals with the energy of emitted light. [See also Abstracts Nos. 725, 2251 (1902); 1119 (1904).] A. W.

1529. *Spectra of Aromatic Compounds due to Action of Ultra-violet Light.* **E. Goldstein.** (Phys. Zeitschr. 13. pp. 577–583, July 1, 1912.)—A continuation of previous work [see Abstracts Nos. 282 (1909); 717, 1051 (1912)]. The author has shown that the emission of the principal spectra of aromatic compounds under the influence of kathode or canal rays is accompanied by a definite physical alteration of the substance. After being affected by the above radiations the same physical alteration may be noticed under the action of purely optical, ultra-violet radiation, but in certain cases the alteration cannot be produced by optical rays alone. The effect of the conditions under which the observed phenomena are produced is discussed at length. The research is being continued. A. W.

1530. *Gas Ionisation by Light, and the Aluminium Spark Spectrum in the Schumann Region.* **T. Lyman.** (Phys. Zeitschr. 13. pp. 583–584, July 1, 1912.)—The author points out the superiority of a hydrogen vacuum tube over the aluminium spark in air as a source of light in all experiments on volume ionisation. In the Al spectrum the author finds a group of lines about 1800 Å. which he considers identical with the active rays in air ionisation. J. M.

1531. *Spark Spectra in the Schumann Region.* **T. Lyman.** (Astrophys. Journ. 35. pp. 341–353, June, 1912.)—The author has photographed the spectra of Al, Ca, Sr, Ba, and Mg, and discovered many of the lines predicted by Ritz and Saunders [see Abstract No. 92 (1911)]. The light from a spark made in helium or in a current of hydrogen passes through a fluorite window directly into a grating (concave) vacuum spectroscope, so that spectra may be studied to the limit of transparency of fluorite. The measurements were made by the method of shifted spectra. J. M.

1532. *Short- and Long-wave Fluorescence Bands.* **M. Gelbke.** (Phys. Zeitschr. 13. pp. 584–585, July 1, 1912.)—According to J. Stark, two kinds of bands are to be distinguished in the band spectrum. This distinction is to be specially noted in the behaviour of bands in fluorescence. If, for example, light is absorbed in the so-called long-wave bands alone, then the fluorescence is of no noticeable amount. If, on the other hand, the light absorption occurs in the short-wave bands, then both in these short-wave bands themselves and also in the related (*gekoppellen*) long-wave bands fluorescence occurs. The present paper records work on ethyl-alcoholic solutions of acetone, diacetyl, and oxalosuccinonitrile. The wave-lengths in use were from 240 to 480 $\mu\mu$. The curves plotted show, for each of the three substances, an intense absorption band in the ultra-violet, and a fainter one for longer waves. The source of light was an intense electric spark; quartz lenses and spectrograph were used. E. H. B.

1533. *Absorption of X-rays and Fluorescent X-ray Spectra.* **C. G. Barkla and V. Collier.** (Phil. Mag. 23. pp. 987–997, June, 1912.)—Continuing the work of Barkla and Sadler [Abstract No. 1049 (1909)] the authors have investigated the absorption of radiations whose penetrating power is close to that of the spectral lines of the absorbing substances. The relation between the absorption in an element R and the absorption measured in a substance whose spectral lines are far removed, *e.g.* Al, is found to be practically identical for all the substances experimented upon. Thus, considering the curves giving the absorption in any element as ordinates, and the absorption in Al of the corresponding homogeneous radiations as abscissæ, if the scales be such that the points giving the absorption of Fe radiation by Fe, Zn radiation by Zn, &c. (spectral lines), be made to coincide, then the whole curves coincide also. This relation is shown to hold for elements of series K and also elements of series L, although the relations in the neighbourhood of the spectral lines of the two series are widely different. Thus the shape of the absorption curves in the region of a spectral line depends on the series to which the spectral line belongs, and not to any appreciable extent upon the particular element in which the absorptions are made. The authors have also determined the absorptions in various gases and vapours, the generality of the laws being further verified by the results. E. M.

1534. *Diffraction of Röntgen Rays.* **A. Sommerfeld.** (Ann. d. Physik, 38. 3. pp. 473–506, June 13, 1912.)—Haga and Wind concluded, from their experiments on the diffraction of X-rays, that the rays had a wave-length of about 10^{-8} cm. Walter and Pohl obtained no evidence of diffraction, and concluded that the wave-length must be less than 10^{-9} cm. [Abstract No. 1224 (1909)]. The author considers that a negative attempt to obtain diffraction does not itself decide against the pulse theory of X-rays, but puts simply an upper limit to the breadth of the pulse. From Walter and Pohl's observations the author deduces a value for the wave-length 3×10^{-9} cm. The author discusses the problem geometrically, and compares the theoretical results of diffraction with some photometrical measurements of Koch. There is substantial agreement between theory and experiment. The general conclusion of the paper is that diffraction of some kind takes place. E. M.

1535. *Asymmetry in the Distribution of Secondary Kathode Rays produced by Röntgen Rays; Dependence on Penetrating Power of Exciting Rays.* **C. D. Cooksey.** (Amer. Journ. Sci. 34. pp. 48–56, July, 1912. Phil. Mag. 24. pp. 37–45, July, 1912.)—It has been shown by Bragg and Madsen [Abstract No. 1445 (1908)] that the amount of secondary β-radiation excited in various solids by γ-rays is not symmetrically distributed about a plane perpendicular to the direction of propagation of the γ-rays, but that the β-radiation which comes from the side from which the γ-rays emerge is greater than that coming from the side on which the γ-rays are incident. The same effect is observed, though to a less degree, in the secondary Röntgen rays, the secondary kathode rays produced by Röntgen rays, and those produced by ultra-violet light [see Abstract No. 550 (1912)]. This lack of symmetry is less for soft γ-rays than for hard, and still less for Röntgen rays, which latter are usually considered as very soft γ-rays. The order of magnitude of emergent to incident radiation ranges from 20:1 down to unity, depending on the nature of the radiations used and the substance in which the secondary rays are excited. In the present experiments homogeneous beams of Röntgen rays of known penetrating powers are employed. The ratio of the emergence to incidence kathode rays produced in gold and silver by beams of fluorescent secondary Röntgen rays is measured with the object of finding the dependence of the ratio on the penetrating power of the exciting rays. The fluorescent secondary Röntgen rays from Sn, Zn, Fe, and Cr are used as exciting rays, representing an increase in absorbability as measured in Al, of about 8000 per cent. between Sn and Cr. After allowing for the absorption of the exciting rays in the layer of the metal from which the kathode rays come and in the air of the ionisation chamber, it is found that there is no definite variation in the ratio of emergence to incidence effect. A. E. G.

1536. *Absorption and Ionisation of Radio-active Recoil Atoms.* **L. Wertenstein.** (Comptes Rendus, 155. pp. 450–458, Aug. 19, 1912.)—By means of diaphragms the author obtains an approximately parallel beam of RaB recoil atoms projected from a disc coated with RaA. A positively-charged plate is placed in the path of the recoil atoms at different distances from the source and under various conditions as regards pressure. Combining the results of several experiments a curve is obtained showing the progressive diminution in the number of projected recoil atoms along the beam. The results show that with air at 1 mm. and hydrogen at 6 mm. pressure, the absorbing powers of the two gases are the same. Under these conditions the diminution of the number of projected particles is very small up to about 5 cm. from the active source. The number then diminishes fairly rapidly, and becomes only a few hundredths of the original value at 10 cm. distance. With further increasing distance the fraction decreases slowly, the effects being due to diffusion of uncharged atoms. Thus the range is found to be about 10·5 cm. for air at 1 mm. pressure, or for hydrogen at 6 mm. pressure. The diminution of the number of recoil atoms towards the end of the range is much sharper in the case of hydrogen than in air, pointing to the conclusion that dispersion by the gas molecules plays a large part in the absorption. The author has also studied the ionisation produced by the recoil atoms, and concludes that the ionisation produced decreases with decreasing speed, *i.e.* the reverse of what takes place with α-particles. The fall of ionisation with speed is more rapid in hydrogen than in air. [See Abstract No. 691 (1912).]

E. M.

1537. *Variations in the Ranges of α-Particles.* **K. F. Herzfeld.** (Phys. Zeitschr. 13. pp. 547–550, June 15, 1912.)—The fact that all the α-particles from a thin layer of a single α-radiating product do not penetrate exactly the same distance in air has been attributed by Geiger (1) to the number of collisions made with gas molecules not being the same for all α-particles; (2) to scattering. The author considers the former reason theoretically. An expression is found connecting the velocity of the α-particle and the number of collisions, and it is shown that the range varies inversely as the density, and should be independent of the molecular distribution. The probability of a definite range is then considered, taking into account the phenomena discovered by Taylor [Abstract No. 1887 (1909)] and also scattering. It is deduced that under certain circumstances the number of α-particles should diminish only over the last 4 mm. of the range. The results are shown graphically. E. M.

HEAT.

1538. *Comparison of Mercury- and Platinum-Thermometers.* **G. Moeller, F. Hoffmann, and W. Meissner.** (Zeitschr. Instrumentenk. 32. pp. 217–229, July, 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Results are shown up to 550° C. For temperatures above 300° a special mercury thermometer is used, filled under pressure and having the gas space above the mercury kept cool by water circulation. Two kinds of Jena glass are employed. Calling g_t the difference between the temperatures given by the mercury- (t_q) and platinum-thermometers (t) respectively we have :—

For Jena glass 59^{III}—

$$g_t = t(t-100)(-2{\cdot}00 \times 10^{-6} + 2{\cdot}4504 \times 10^{-7}t + 5{\cdot}120 \times 10^{-11}t^2).$$

For Jena combustion-tube glass—

$$g_t = t(t-100)(+2{\cdot}85 \times 10^{-6} + 2{\cdot}5444 \times 10^{-7} + 4{\cdot}320 \times 10^{-11}t^2).$$

g_t increases from above 1 deg. at 200° C. to about 28 deg. at 500° C. Results for the absolute expansion of mercury are to follow. P. E. S.

1539. *Temperature Variation of Thermal Expansion Coefficients.* II. **C. L. Lindemann.** (Phys. Zeitschr. 13. pp. 737–744, Aug. 15, 1912.)—The coefficients of expansion of rock-salt, quartz, glass, and boric acid have been determined for temperatures from 20·4° abs. upwards. The results show that Gruneisen's relation [compare Abstract No. 888 (1912)] is approximately true only for those substances in which the relation between the temperature and the atomic heat can be represented by a single specific frequency (Eigenfrequenz), as is probably the case with rock-salt. The results of the whole investigation point to the disappearance of the coefficient of expansion at the absolute zero. The coefficient of expansion in no case, with the possible exception of rock-salt, decreases more quickly than the specific heat—a result which indicates probably that the slow frequencies have the greatest effect on the coefficient of expansion. T. S. P.

1540. *Heat of Evaporation of Liquid Air.* **G. Witt.** (Ark. för Mat. Astron. och Fysik, Stockholm, 7. 32. pp. 1–13, 1912.)—The liquid air was contained in a Dewar vessel and a known amount of heat added by passing an electric current through a resistance immersed in the liquid. The amount of liquid evaporated was determined by measuring the volume of air expelled, blank experiments also being carried out to determine the rate at which evaporation takes place when no heat is applied. Since the latent heat of vaporisation varies with the composition of the liquid air, it was necessary to determine the composition. This was done by measuring the temperature of the liquid during the experiments by means of a thermo-junction and calculating the composition from the boiling-point by means of Baly's measurements [Abstract No. 1884 (1900)]. The latent heat (L), in gm. cals. is given by the equation $L = 49{\cdot}59 + 0{\cdot}0143p$, where p is the percentage of oxygen in the liquid air. The latent heats of nitrogen and oxygen are therefore 49·59 and 51·92 gm. cals. respectively. By the application of Clapeyron's equation to the experimental results obtained by other observers for the boiling-point, difference in specific volumes of the liquid and gas, and alteration of the boiling-point with the pressure of pure nitrogen and oxygen the latent heats are calculated to be 48·9 and 51·4 gm. cals. respectively, which values are in good agreements with the author's experimental results. [See Abstract No. 1034 (1900).] T. S. P.

1541. *The Second Law of Thermodynamics.* **C. P. Steinmetz.** (Engineer, 114. pp. 103–104, July 26, 1912. From the "General Electric Review," Schenectady. Mech. Eng. 30. pp. 123–125, Aug. 2, 1912.)—The author discusses the second law of thermodynamics and points out several popular misconceptions in connection with it. He concludes that the second law of thermodynamics is not a universal law of nature, but applies only within the limited range of thermodynamic engines from which it has been derived. It does not apply to the universe as a whole; and the conclusion sometimes deduced from it, that the universe must finally come to a standstill, is not justified. A. R.

1542. *Combustion of Nitrogen in Explosive Gas Mixtures.* **F. Häusser.** (Zeitschr. Vereines Deutsch. Ing. 56. pp. 1157–1164, July 20, 1912.)—The experiments were made in 1906 with steel vessels lined inside with enamel. The explosion pressure was determined with the aid of a Rosenkranz indicator which in the large vessel of 1651 cm.^{3} capacity gave smooth curves of pressures, whilst the original smaller vessel of 552 cm.^{3} showed oscillations. The temperatures were deduced from the pressures. For rapid cooling, a jet of water could be injected into the vessel by a weight of 8 kg. falling 1·8 m. upon a plunger; the same weight closed the primary circuit of an induction apparatus, the secondary of which comprised the spark-gap consisting of two Pt-wires. The vessel was evacuated and charged with an explosive mixture, either illuminating gas and air, or CO and air. The NO resulting from the explosion was absorbed by the injection water or, when no injection was applied, by water with which the enamel was wetted. In the small vessel the formation of NO and of nitrous and of nitric acids corresponded fairly to the purely thermal reaction according to Nernst; in the large vessel the yield of NO was about 100 per cent. greater than the theoretical results. The different experiments were concordant. The quenching of the gases by injected water raised the yield by 20 and (in the CO mixtures) by 50 per cent., and the pressure curves showed then an abrupt drop; the quenching is, however, troublesome in large vessels. The initial pressures were about 8 atmos. abs., the explosion pressures about 25 atmos., and the deduced temperatures about 2130° C. abs. As the yields were higher than the assumption of a purely thermal reaction would justify, and as electric influences (such as Haber has suggested) were out of the question in these explosion experiments, the author suspects photochemical influences. He has based a technical process of nitrogen combustion on his experiments, and a plant is being built at the de Wendel Colliery near Hamm. Experiments made with gas engines at Dahlhausen and elsewhere are described by **Dobbelstein** (Glückauf, 48. pp. 289–300, Feb. 24, 1912). The explosion chamber has a capacity of 100 litres; water-cooling was not applied, but oxygen added to the coke-oven gas in some experiments. H. B.

1543. *Diagram of State of Carbon Dioxide.* **G. Tammann.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 4. pp. 446–452, 1912.)—From earlier results the author had drawn the conclusion ("Schmelzen und Krystallisieren," p. 294, 1903), that, from —56·7° and 5·1 atmo. pressure to —7·5° and 2800 kg. per sq. cm., liquid CO_2 deposits crystals of a different kind from those

separated under higher pressures. The co-ordinates of the melting-point curve of CO_2 between pressures of 2800 and 3800 kg. have now been redetermined, the results showing that from a pressure of 1 kg. to the pressures just named, CO_2 exists in only one stable crystalline form; this is what would be expected with a non-associated liquid such as CO_2. As a consequence of these results there is now no known exception to the rules: (1) only molecules already present in a liquid take part in the formation of crystals, and (2) with non-associated liquids there corresponds only one stable crystalline form.
T. H. P.

1544. *The State Equation of Monatomic Solid Bodies, and the Quanta Theory.* **S. Ratnowsky.** (Ann. d. Physik, 38. 3. pp. 637–648, June 18, 1912.)—A theoretical paper of which the following are the results:—The proper frequency of a resonator is to be regarded as a function of the volume, owing to the existence of internal potential energy (Volumenenergie). (2) On this premiss and the assumption of the existence of a force acting between the molecules, an equation of state for true solid substances can be deduced from the quanta hypothesis. (3) From the equation of state so found three conditions for ν, the proper frequency, can be found. (4) The equation of state thus derived is more general than that of Grüneisen, since it also takes account of the dependence upon the temperature of the values (Zustandsgrössen) involved.
L. H. W.

1545. *Apparatus and Method for Exact Calorimetric Measurements.* **O. Richter.** (Zeitschr. Instrumentenk. 32. pp. 177–185, June, and pp. 234–241, July, 1912.)—A detailed description of a Bunsen ice-calorimeter and of the heater used for the material of which the specific heat is to be determined. The specific heats of metals and alloys determined with this apparatus are accurate to the fifth place of decimals.
T. S. P.

1546. *Very High Temperatures.* **J. A. Harker.** (Chem. News, 106. pp. 85–87, Aug. 23, and pp. 97–98, Aug. 30, 1912. Discourse delivered before the Royal Inst., Feb. 9, 1912. Nature, 89. pp. 514–518, July 18, 1912. Abstract.)

1547. *On Some Relations holding for the Critical Point.* **J. J. van Laar.** (Konink. Akad. Wetensch. Amsterdam, Proc. 14. pp. 771–781, Feb. 22, 1912.) —A theoretical paper which does not permit of brief abstraction.

1548. *The Definition of an Ideal Gas.* **E. F. Farnau.** (Phys. Rev. 35. pp. 47–57, July, 1912.)—An attempt to discuss the question theoretically from a standpoint somewhat different to that of Buckingham [see Abstract No. 702 (1910)].

SOUND.

1549. *Vibration Curves of Violin.* **E. H. Barton** and **W. B. Kilby.** (Phil. Mag. 24. pp. 885–891, June, 1912.)—A continuation of previous work [Abstracts Nos. 448, 1086 (1907), 1298 (1910), and 874 (1911)]. Investigates the simultaneous motions of the strings of a violin and the air at a sound-hole. In order to detect the vibrations of the air, part of this sound-hole was covered with a thin membrane connected to a rocking mirror. The strings were excited at two or more places by bowing, plucking, and striking. Of 140 plates exposed, 61 reproductions are given. E. E. F.

1550. *Composition of Two Simple Vibrations by a String.* **A. I. Steven.** (Phil. Mag. 23. pp. 977–981, June, 1912.)—A string is stretched horizontally between two tuning-forks of frequencies in the ratio of the vibrations to be compounded. Hence the string is under the *double* forcing due to each fork when sounding simultaneously. The adjustment of length must be made as in Melde's experiment. The two vibrations may be in the *same* plane, say *vertical.* Or, they may be in perpendicular planes. This can be obtained by making the direction of vibration of one fork horizontal at right angles to the length of the string. But this usually leads to a circular motion of the string, which is not wanted. It seemed therefore preferable to use the longitudinal form of Melde's experiment, which then under this double forcing always resulted in two vibrations at right angles, although the reason for this behaviour is not apparent. In this way any of Lissajous' figures may be obtained, and the paper gives photographs of some so produced. E. H. B.

1551. *String Vibrations maintained by Forces of Double Frequency.* **J. H. T. Roberts.** (Phil. Mag. 23. pp. 931–936, June, 1912.)—Describes observations of Melde's experiment in the longitudinal form where the maintainer is of double the frequency of the vibrations maintained. The following are the chief conclusions reached: (1) The range of length over which a string can be maintained in vibration by a given fork is so great as to render the ordinary form of Melde's longitudinal experiment useless for the determination of the frequency of a fork. The period of vibration of a string can accommodate itself by adjustment of plane as well as by adjustment of amplitude. (2) The length of the string when vibrations of very small amplitude just begin is considerably less than the theoretical length; when the *theoretical length is reached the plane of vibrations becomes vertical*, and this provides a means of making the experiment definite. (3) When the length is greater than the theoretical length, the amplitude increases until, at a certain length, vibrations are only possible when they exceed a certain critical initial amplitude; this critical amplitude increases with further increase of length. At a still greater length the reaction upon the fork is very considerable indeed. (4) By stroboscopic examination, a string is found to have different periods, for the same amplitude, when free and when maintained; its maintained vibration must be to some extent a forced vibration. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1552. *Electrical and Mechanical Translation Surfaces in Metals.* **J. Stark.** (Phys. Zeitschr. 13. pp. 585–589, July 1, 1912.)—Discusses a theory of atomic and electronic structure in metals and metallic crystals involving surfaces of easy translation in which the valency electrons may be easily moved by electric force, so that electrically and mechanically this region plays an important part in the theory of the structure. The conception is illustrated by five diagrams showing the positively- and negatively-charged components in various configurations. E. H. B.

1553. *Kinetic Theory of Electric Doublets.* **M. Reinganum.** (Ann. d. Physik, 38. 3. pp. 649–668, June 18, 1912.)—A mathematical paper treating the forces between electric doublets according to the methods of statistical mechanics, and applying the results to molecules and ions. Between two doublets the mean force is found to vary as the *inverse seventh* power of the distance, and to be inversely as the absolute temperature. E. H. B.

1554. *Electrodynamics derived from Electrostatics.* **L. Page.** (Amer. Journ. Sci. 34. pp. 57–68, July, 1912. Phys. Zeitschr. 13. pp. 609–615, July 1, 1912.)—Maxwell's electrodynamic equations are based upon three experimental laws: (1) The inverse square law for the electric force between two point changes relatively at rest; (2) Ampère's law for the force between current-elements, or its equivalent; (3) Faraday's law of current induction. The object of the present paper is to show, that if the principle of relativity had been enunciated before the date of Oersted's discovery, the fundamental relations of electrodynamics could have been predicted on theoretical grounds as a direct consequence of the fundamental laws of electrostatics, extended so as to apply to charges relatively in motion. Of course, only that part of the theory derived from the principle of relativity that is independent of any *a priori* knowledge of the electrodynamic equations, will be made use of; that is to say, only the *kinematics* of relativity, and not its dynamics, is used. Proceeding thus, the author obtains (*a*) the expression for the electric intensity due to a charge moving relative to the observer; (*b*) Ampère's law, or its equivalent; (*c*) Faraday's law, or its equivalent. Viewed from another standpoint, the author considers that the possibility of thus deducing the fundamental relations of electrodynamics from those of electrostatics, by aid of the principle of relativity, affords some confirmation of this principle. E. H. B.

1555. *Force between Two Charged Conductors—Sphere and Plane.* **A. Guillet** and **M. Aubert.** (Comptes Rendus, 155. pp. 139–141, July 8, 1912.)—Certain electrometric determinations are facilitated by the use of an apparatus consisting of a sphere and a plane or of two spheres. The first of these is considered here, and formulæ are deduced which simplify the numerical calculations. The spherical conductor S, of radius a, is earth-connected; its centre C is at the distance e from the plane conductor S′, which is raised to potential V. Then Kelvin's *point images* are divided into two groups: I_{2p+1}, images taken with regard to S; I_{2p}, images taken with regard to S′. Denoting by m_k the charge on the image k and by $r_{k,k'}$ the distance apart of the images k and k', Murphy's theorem gives for the force F exerted on S′—

$$F = m_1 \Sigma \frac{m_{2p}}{r^2_{1,2p}} + m_3 \Sigma \frac{m_{2p}}{r^2_{3,2p}} + \ldots$$

This is finally expressed in terms of polynomials in $u(=e/a)$. The properties of these polynomials, which are related to the polynomials of Legendre, are briefly dealt with, and the method of calculating F and its point of application shown. A. W.

1556. *Absolute Electrometer.* **A. Guillet** and **M. Aubert.** (Comptes Rendus, 155. pp. 204–206, July 16, 1912.)—A simple absolute electrometer is made by suspending a very light hollow spherical conductor by means of a long thin wire from a sensitive dynamometer, of any form whatever, a plane horizontal conductor being placed below [see preceding Abstract]. The sphere being earth-connected and the plane raised to potential V, an index attached to the wire may be used to indicate, on an appropriate scale, the force F between the two conductors. By suitably choosing a (the radius of the sphere), the sphere can always be placed at a distance $\delta = a(u-1)$ from the plane greater than the sparking distance Δ, the force F remaining constant. A small conical plug at the end of the wire facilitates the substitution of one sphere for another, the spheres being provided with corresponding conical holes. If u lies between 1·36 and 3, the potential V may be calculated from the approximate formula $F = -V^2/[4(u-1)(u+0{\cdot}078)]$. The apparatus described constitutes an excellent electrometric sparking arrangement. The potential V is progressively raised, the sphere gradually descends, and the spark takes place at the instant when δ takes the value Δ. A table of results is given using a sphere of 14 mm. radius, Δ varying between 1 and 10 mm. From these we get $V = 105\Delta$, where V is in e.s. units and Δ in cm. Hence the sparking potential in this case for $\Delta = 1$ cm. is 31,500 volts. A. W.

1557. *The Theory of Dielectrics.* **T. Bialobjeski.** (Le Radium, 9. pp. 250–259, July, 1912.)—The author first gives a *résumé* of the properties of dielectrics. He shows how these phenomena may be explained by the principle of superposition of effects and describes a model, of parallel layers having different dielectric coefficients, which could reproduce these phenomena. Finally he discusses the anomalous behaviour of ionised dielectrics and gives possible explanations of the phenomena. A. R.

1558. *Silent Electric Discharges over the Andes Mountains.* **W. Knoche.** (Meteorolog. Zeitschr. 29. pp. 329–330, July, 1912.)—On the suggestion of the author a miner, K. Rahmer, living at the Coya railway station, near Santiago, Chili, observed the so-called Andes-glow in the latter half of Dec., 1911, noting, *e.g.*, ten observations between 8 and 9 p.m. The glows seemed to start from a ridge from 3000 to 3500 m. in height (the station itself lies at 800 m. altitude), or from conical peaks. They are described and illustrated as luminous arcs, up to 25° in width, surrounding a dark core, or as rays shooting up singly or in radial groups for a few seconds, sometimes as far as the zenith. The phenomenon is frequent on warm nights following hot days, with clear sky or not much clouded sky; the following morning the cloudiness would generally appear increased. H. B.

1559. *Derivation of the Lorentz Transformation.* **P. Frank** and **H. Rothe.** (Phys. Zeitschr. 13. pp. 750–758, Aug. 15, 1912.)—A mathematical discussion [see Abstracts Nos. 1570 (1910) and 5 (1912)]. E. H. B.

1560. *Determination of Elementary Electrical Charges in Metallic Dust.* **A. Mayer.** (Phys. Zeitschr. 13. pp. 754–755, Aug. 15, 1912.)—Reviewing the available data the author derives the following result :—

$$10^{10}e(\text{mean value}) = 4{\cdot}88 \pm 0{\cdot}10. \qquad \text{E. H. B.}$$

1561. *Trajectory of an Electrified Particle in a Magnetic Field.* **R. Birkeland.** (Comptes Rendus, 155. pp. 447–450, Aug. 19, 1912.)—Mathematical.

1562. *Theorem of Sufficient Cause.* **R. Becker.** (Deutsch. Phys. Gesell., Verh. 14. 12. pp. 646–649, June 30, 1912.)—Discusses some physical applications of the principle of sufficient cause. [See Abstracts Nos. 898 and 1242 (1912).] E. H. B.

DISCHARGE AND OSCILLATIONS.

1563. *Diffusion of Alkali Salt Vapours in Flames.* **H. A. Wilson.** (Phil. Mag. 24. pp. 119–125, July, 1912.)—The light emitted by flames containing alkali salt vapours appears to be due to the atoms of the alkali metal probably electrically neutral, but possibly positively charged. Probably an atom of the metal under the influence of the violent collisions with the other atoms loses negative electrons and so becomes a positive ion. Since, however, many free negative electrons are present in the flame even in the absence of salt, it seems certain that such a positive ion must soon be neutralised by recombination with electrons. The metal atom therefore will be a positive ion only for a fraction of the time. The process of recombination probably sets up vibrations inside the atom which produce radiation, so that the radiation is emitted by the atoms when neutral, or at any rate when with less than their max. positive charge. The great facility with which the alkali metals lose electrons makes it possible that at the very high temperatures of the flame they may lose more than one negative electron. The following method is here used to get the coefficient of diffusion :—A small bead of salt on a Pt-wire is put in the flame and the shape of the region surrounding the bead which emits light is measured. From this and the velocity of the flame gases the coefficient of diffusion can be calculated. The shape of the region emitting light is rather like an ellipsoid of revolution with the long axis vertical and the bead at the lower focus. The coefficient of diffusion K is then given by $K = (vr_m/2x_m)(r_m - x_m)$, where v = velocity of flame gases and r_m and x_m denote the values of r and x at a point where the diam. is a maximum, r being $= \sqrt{x^2 + y^2 + z^2}$. A special method of obtaining a steady flame is described. It appears from results obtained that caesium, rubidium, and potassium salt vapours diffuse at nearly equal rates, while sodium and lithium diffuse more quickly. The velocity of positive ions of alkali salt vapour in flames appears to be about 60 cm. per sec. per volt/cm. at high temperatures. From calculations given it appears that the average charge on Li and Na atoms in the flame is about equal to that on hydrogen ions in solutions, while the average charge on Cs, Rb, and K atoms is nearly three times greater. Langevin has suggested that the positive ions due to salt vapours in flames are hydrogen atoms, but no suggestion has been made to show how the hydrogen ions are produced; and moreover, the experiments made to determine the ionic velocities cannot be explained satisfactorily on the view that the ions are hydrogen atoms. Also salt vapours produce enormous conductivities in flames which contain no hydrogen. The increase of current observed in the determinations of the ionic velocities is nearly proportional to the conductivities due to the salt vapours, which shows that the ionic velocities measured are not those of a few special ions produced by some secondary reaction, but are the velocities of the majority of the ions due to the salts which must be formed from the salts, and therefore cannot be hydrogen. A. E. G.

1564. *Velocity of Secondary Rays Liberated by Canal Rays.* **H. Baerwald.** (Deutsch. Phys. Gesell., Verh. 14. 18. pp. 675–680, July 15, 1912.)—The velocity of secondary rays liberated from solid substances by canal rays has been found by C. Füchtbauer to be 80 volts [see Abstract No. 2067 (1906)], while Lenard has shown that secondary rays due to kathode rays have a velocity of only 10·8 volts. In the present experiments the velocity of the secondary rays set free from solid bodies by canal rays is found to be of the same order of magnitude as those liberated from solids by kathode rays. This points to similarity in the mechanism of procedure in the two cases. Further experiments are in progress. A. E. G.

1565. *Measurement of the Saturation Current Curve in Air Ionised by Röntgen Rays.* **H. Seemann.** (Ann. d. Physik, 38. 4. pp. 781–829, July 12, 1912. Extract from Dissertation, Königsberg.)—The null electrometer method as used by Rutherford, in which the unknown condenser resistance is balanced by a known resistance, is used for measuring the current which at any given voltage is sent through the condenser. A special method of obtaining the curve graphically is described, and a photographic illustration of the apparatus employed for this purpose is given. A collection of the formulæ usually employed and handy tables are considered at some length. The results show that the saturation current curve from 0 to 0·7 saturation value obtained for dry air ionised by Röntgen rays in a glycerine-soaked tissue paper condenser with parallel plane circular-formed electrodes 80 sq. cm. surface and 2–5 cm. apart, is in complete accord with the theoretical curve of Mie and Seeliger. From 0·8 to 0·95 saturation value the practical are from 1 to 1½ per cent. below the theoretical values. It seems therefore quite permissible to neglect effects due to diffusion for currents up to 0·7 saturation value. Calculations of the ion constants from the curve, by the usual theories of Thomson, Mie, Riecke, and Seeliger give false values. The explanation of this deviation may possibly be found in the initial recombination which occurs. [See also Abstracts Nos. 1218 (1908) and 1745 (1904).] A. E. G.

1566. *Photoelectric Potentials of Thin Kathode Films.* **P. H. Dike.** (Phys. Rev. 34. pp. 459–470, June, 1912.)—Millikan carried out observations with plates which were kept for months in very high vacua with frequent prolonged exposure to intense ultra-violet light. By this means he obtained much higher photoelectric potentials for Fe, Zn, Cu, Ag, and Al than any previous observer. In all cases the potential was many times higher than when the plate was first put into the tube. The present experiments were undertaken with the hope of producing similar effects. The surface of the plate to be tested was cleaned by using it as kathode, and numerous tests were made in two tubes of different types, in atmospheres of hydrogen and nitrogen at very low vacua, using Cu and Fe as the metals to be tested. The potential to which either of these metals is raised by the action of ultra-violet light from the quartz mercury arc can be only slightly increased by prolonged use as a kathode. The highest value observed for the photoelectric potential of Cu is 4 volts, and for that of Fe 8·1 volts. As this method did not produce the high potentials expected, the plate to be tested was next used as a receptacle for a kathode deposit, and its photoelectric properties were examined under various conditions and with varying thickness. By this means it is shown that photoelectric potentials of a Pt surface can reach values more than twice as high as any previously observed, and many times higher than any before obtained with the quartz mercury arc. These high potentials are observed only with very thin kathode films of the order of thickness 5×10^{-8} cm., or with coloured films of greater thickness, up to at least a half wave-length of sodium light. A sudden drop in potential occurs with uncoloured films at the same thickness as that at which Patterson found a rapid increase in the electrical conductivity of Pt films. With coloured films on quartz, and films on Pt, the velocity of the projected electrons is found to increase with the time up to about 36 hours, independently of the illumination and the state of the vacuum. A. E. G.

1567. *Nature and Velocity of Migration of Carriers of Electricity in Flames containing Metallic Vapours.* **E. N. da C. Andrade.** (Phil. Mag. 23. pp. 865–884, June, 1912.)—Lenard has shown that if a bead of salt of one of the alkali metals be brought into the Bunsen flame, the coloured streak so formed is deviated in an electric field, and behaves as if positively charged [see Abstract No. 650 (1903)]. He estimated the velocity of migration of the carriers in unit field from the inclination of the luminous streak and the upward velocity of the flame. H. A. Wilson, by using two horizontal electrodes in the flame itself, had previously measured the velocity of the positive carriers by driving them down against the current of the flame gases: he estimated the field required to bring them to the lower electrode by the current between the electrodes. The value obtained by Wilson is about 1000 times as great as that of Lenard, *e.g.* for lithium he finds 63 cm./sec. per volt/cm., while Lenard finds 0·08 cm./sec. per volt/cm. From this Lenard infers the probability of the existence of two kinds of positive carriers. The object of the present experiments is to establish the simultaneous existence of, and distinguish between, the two kinds of positive carriers, and especially to show the existence of both kinds with a common method. In the arrangement employed the flame is placed between two plate electrodes, one earthed, the other insulated and connected with an electric machine; the fast-moving positive carriers are in this way driven sideways out of the flame, and some of them fall upon an insulated Pt strip which is connected to earth through a high-resistance galvanometer, and is fixed close to the earthed electrode so that the uniformity of the field is not disturbed by it. The presence of the carriers is detected by the current through the galvanometer caused by the introduction of the bead of salt into the flame. The following conclusions are arrived at as the result of experiments described:—The positive carrier in a flame containing metal vapours is of metallic nature, very probably the metal atom. It has two different definite velocities of migration in the electric field, according as it is present in the streak of metallic vapour or in the free flame: in both cases it alternates the positive with the neutral state. In the former case it is charged for about $\frac{1}{400}$ of the time, in the latter for $\frac{1}{3}$ of the time. For strontium the greater velocity of migration is

2·5 cm./sec. per volt/cm. Other experimenters have found that the velocity is the same for different metals, hence the above value is probably the velocity of migration of an atom of any metal in the free flame. The presence of glowing Pt in the vapour causes the liberation of electrons from it in large quantities. There exist, besides the free electrons, relatively small numbers of negative carriers of the second kind which are metallic. This gives an analogy with the canal rays. A critique of previous work on the subject is at the end of the paper. A. E. G.

1568. *Absorption in Geissler Tubes and Allied Phenomena.* **B. Hodgson.** (Phys. Zeitschr. 13. pp. 595–609, July 1, 1912.)—Willows [Abstract No. 1518 (1901)] and Riecke have carried out experiments upon the connection which exists between the amount of gas absorbed, the pressure, and the current flowing through the tube. Their results are not in good agreement. Willows has further studied the appearances in tubes of various kinds of glass with electrodes of different shapes and sizes. In the present experiments the tube is arranged so that the electrodes can easily be changed when desired; they are a repetition of the experiments of Willows and Riecke, using a continuous current. The curves obtained are in agreement with those obtained by Willows, the flat portion of Riecke's curve not appearing. It is thought that one of the gases containing carbon may be the cause of the absorption, and to test this experiments were conducted with Al electrodes in an atmosphere of CO_2. The results of this are very irregular, but it is clear that the absorption of gas is only about twice as rapid as when the surrounding gas is nitrogen. It may be that the condition of the electrode itself exerts an important influence on absorption. Spherical electrodes, 9 mm. diam., of Al, Zn, Cu, Fe, and Pb were employed in atmospheres of hydrogen, nitrogen, oxygen, and helium, and the results obtained are given in tabular and diagrammatic form. To account for the phenomena observed the following theory is proposed:—The metallic electrodes initially hold gas in two conditions: as surface layer, and as occluded gas. When the apparatus has remained for some time in a resting condition a state of equilibrium between the occluded gas, the surface layer and the gas in the tube is arrived at. When the current passes the kathode gives up, and the anode absorbs, gas. The gas initially given off comes probably for the most part from the kathodic surface layer. When the surface layer is wholly or partially removed the occluded gas is no longer in equilibrium with the remaining surface layer, but gas will diffuse from the metal to the surface and from there into the tube space. At the anode the reverse process takes place, the gas being driven by the current into the surface layer so that the pressure there is now greater than that of the occluded gas in the substance of the metal: gas therefore diffuses into the metal. The pressure alteration which is observed while the current is passing is therefore apparently a differential effect. The fall of potential at the kathode varies in the same gas with the metal used. It would seem probable that when the condition of the surface layer alters the kathode-fall will likewise alter. Zinc electrodes in hydrogen were tested by allowing the current to pass through the tube for several days, but no marked alteration in the kathode-fall takes place. A. E. G.

1569. *Disruptive Discharge through Pure Sodium Vapour.* **L. Dunoyer.** (Comptes Rendus, 155. pp. 270–273, July 22, 1912.)—The author has previously shown that in all probability pure sodium vapour does not differ in conductivity from ordinary gases [see Abstract No. 1482 (1912)]. In the present experiments the discharge is produced in pure sodium vapour between parallel circular discs of Ni. The diam. of these electrodes is about 2 cm., and their distance apart 0·8 cm. A battery of accumulators is used to produce the required voltage. It is found that the curve connecting the disruptive voltage and the temperature of the vapour has its abscissæ contracted in agreement with the law of variation of the max. elastic force of the vapour with the temperature. But the ordinates remain unaltered, and the curve presents a minimum at about 250° C. The ordinate of this minimum indicates that the minimum voltage of discharge is 335. This quantity for sodium vapour is therefore not different in order of magnitude from that obtained with other gases. The product ap (a = distance of electrodes, p = pressure) for which the minimum disruptive voltage is reached is remarkably low. Thus Townsend found for air $(ap)_m=0{\cdot}55$, for hydrogen $(ap)_m=1{\cdot}55$, a being in cm. and p in mm. of Hg. The value for sodium vapour is found to be $(ap)_m=0{\cdot}04$. This value is undoubtedly only approximate, since the vapour tension of Na at 250° C., the temperature at which the minimum is reached, is not definitely known. It is concluded from this that the ions taking part in the discharge in sodium vapour ought to consist of a considerable number of atoms, probably of the order of 20. A. E. G.

1570. *After-luminosity of Electric Discharge in Hydrogen Observed by Hertz.* **R. J. Strutt.** (Roy. Soc., Proc. Ser. A. 86. pp. 529–533, June 27, 1912.)—Hertz described a phenomenon of after-luminosity which he observed in hydrogen by passing a series of jar discharges through a small discharge tube with an open end, arranged inside a bell-jar. It was observed that at each discharge a stream of luminous gas was squirted from the end of the small discharge tube into the bell-jar. He sometimes observed a jet of blue luminosity, which was best developed at a pressure of 100 mm., and considered he had good evidence that this luminosity showed the hydrogen spectrum, but he found an unaccountable capriciousness of the effect, which sometimes refused to appear at all. He did not succeed in tracing the cause of this uncertainty. Goldstein made similar experiments; he states that the spectrum consists of at least 10 bands, from the green to the ultra-violet, totally unrelated to the hydrogen spectrum. But he believed that the glow was due to pure hydrogen. With the apparatus described the spectrum of the glow is now obtained, and is found to be identical with that obtained when active nitrogen is passed over heated sulphur. The blue glow in hydrogen, then, is connected with the presence of sulphur as an impurity in the gas. On cooling in liquid air an annexe of the vessel in which the glow is observed so as to condense out sulphuretted hydrogen (or any other sulphur compound) the glow disappears completely in one or two minutes. On removing the liquid air, and allowing the glass to warm up, it is restored to its full brilliancy. A. E. G.

1571. *Stationary Electric Waves.* **K. F. Lindman.** (Ann. d. Physik, 38. 3. pp. 523–558, June 18, 1912.)—The determination of the wave-length of stationary waves in air by Hertz with resonators was shown by Sarasin and de la Rive to be a method which might lead to other wave-lengths if different resonators were used. Indeed the latter spoke of multiple resonance, and thought a spectrum was produced by the oscillator. It was then explained by Hertz, Poincaré, and Bjerknes as due to the damping of the waves emitted by the oscillator being much greater than those elicited in the resonator. The present author set out to test the objective existence of stationary electric waves in the air when those from an oscillator were normally reflected. This he did by using a quasi-resonator so strongly damped as to be practically an indifferent detector. He thus obtained definite proof of the objective character of the stationary waves. E. H. B.

1572. *Vibration of a Lecher System.* **F. C. Blake** and **C. Sheard.** (Phys. Rev. 35. pp. 1–26, July, 1912.)—It is a continuation of previous work, but here a thermo-couple was used: the oscillator was here of the Lecher type. The chief conclusions reached are as follows:—(1) Both forced and free oscillations may exist simultaneously on the Lecher system, the overtones of the oscillator being the odd series, while the free overtones of the Lecher system are as the natural numbers. When the two circuits are in resonance only the odd harmonics are present to any appreciable extent. (2) The influence of the receiver upon the wave-system was studied, both selective and non-selective receivers being used, and quantitative results obtained. (3) It was found that under certain conditions the Lecher circuit and either of the other circuits behaved in fact as a single circuit, and in one case all three circuits vibrated as a single circuit. (4) Drude's theory of stationary waves explains the facts fairly well, and by it the damping of the oscillator was measured. [See Abstracts Nos. 1213, 1214 (1911).] E. H. B.

1573. *Kathode Rays of Small Velocity produced in Incandescent Lamps.* **L. Houllevigue.** (Journ. de Physique, 2. Ser. 5. pp. 523–534, July, 1912. Communication to the Soc. franc. de Physique.)—A more complete account of the work dealt with in Abstract No. 1085 (1912), including reproduced photographs showing the various effects observed. L. H. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1574. *Inertia and Sensitivity of Cells Sensitive to Light.* **B. Glatzel.** (Deutsch. Phys. Gesell., Verh. 14. 12. pp. 607–623, June 30, 1912.)—The author has previously given a method based on the use of intermittent lighting, of determining the inertia of cells which are sensitive to light, and equations were obtained for the lighting inertia α and for the inertia of darkening β. In the present experiments selenium and antimony cells were used, and the inertia was tested under different conditions. With the selenium cell it is found that both α and β are independent of the electric pressure, but both are dependent, to a marked degree, upon the strength of the illumination. The previous illumination has much greater effect upon β than upon α. With the lowering of the temperature a strong mounting of the sensitivity occurs, but this is accompanied by a considerable increase in the inertia. The dependence of the inertia upon the colour of the light is also investigated. With the antimony cells the inertia curves are similar to those obtained with selenium cells, and they are dependent to the same extent upon the strength of the illumination. Within the limits of the observations the antimony cell is not influenced by temperature alterations. The antimony cell is also found to be 24 times as sensitive as a selenium cell with Pt electrodes. A. E. G.

1575. *Electrical Properties of Copper-Zinc Alloys.* **L. Norsa.** (Comptes Rendus, 155. pp. 348–351, July 29, 1912.)—The author has determined the conductivity, the temperature coefficient, and the thermoelectric power of 23 alloys of Cu and Zn, containing from 3·15 to 98·8 per cent. Zn. Plotting the results in curves indicates in all cases the existence of compounds corresponding to the formulæ CuZn, $CuZn_3$, and $CuZn_6$. W. H. Sr.

1576. *Specific Resistance and Absorptive Power of Tungsten at High Temperatures.* **M. v. Pirani.** (Phys. Zeitschr. 13. pp. 753–754, Aug. 15, 1912.)—In reply to Corbino [Abstract No. 1064 (1912)] the author points out that Corbino had relied upon former determinations (1910) made by the author, and that it is necessary to distinguish experiments made with glowing wires of uniform temperature from experiments made with loops provided with electrode-holders. In his new experiments the author bends and folds a ribbon of tungsten, 1·25 mm. in width, 60 mm. in length, 0·05 mm. in thickness, in a peculiar fashion, so that the middle portion of the ribbon consists of a double strip leading to a kind of conical cap, which radiates more or less like a black body; potentiometer wires of tungsten, 0·03 mm. in thickness, are attached to the ends of the strip, whilst the current enters at the far ends of the ribbon. The values thus obtained at temperatures up to 2000° differ little from those of 1910. H. B.

1577. *Standard Air-condensers.* **H. Schering** and **R. Schmidt.** (Zeitschr. Instrumentenk. 32. pp. 253–258, Aug., 1912. Communication from the Physikal.-Techn. Reichsanstalt.)—Describes the construction of a set of standard air-condensers, two of 0·001 mfd., one of 0·002 mfd., one of 0·005 mfd. and a variable one having a maximum value of 0·002 mfd. Any one of these is built up of horizontal circular plates, some of which are connected to a cylindrical case which contains them and to which contact is made. Connection with the remainder, which are insulated, can be made either through a hole in the top of the case or by means of a projecting pin which passes through a hole in the centre of the base of the case. With such a construction, when one condenser is placed on the top of a second, the outer cases are electrically connected and the two insulated systems are also in contact so that the capacities are added without serious complications arising from the connections. The following tables give the nominal and measured values:—

Condenser.	Nominal Value.	Measured Value.	Difference Parts in 1000.
A	0·001 mfd.	0·0010001 mfd.	0·1
B	0·001 „	0·0010001 „	0·1
C	0·002 „	0·0019997 „	0·15
D	0·005 „	0·0050002 „	0·04

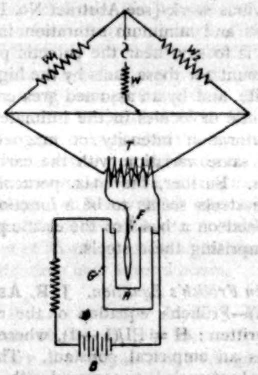
Condensers.	Summation Value.	Measured Value.	Difference Parts in 1000
A + C	0·0029998 mfd.	0·0029994 mfd.	0·13
B + C	0·0029998 „	0·0029994 „	0·13
A + B + C	0·0039999 „	0·0039990 „	0·22
A + B + C + D	0·0090001 „	0·0090010 „	0·12

F. E. S.

1578. *The Self-induction of Electric Currents in a Thin Anchor-ring.* **Rayleigh.** (Roy. Soc., Proc. Ser. A. 86. pp. 562–571, June 27, 1912.)—In the first edition of the "Compendium of Formulæ on Inductance," by Rosa and

Cohen [see Abstract No. 1841 (1908)], Rayleigh's and M. Wien's formulæ for the self-inductance of an anchor-ring are compared and preference is given to the latter. The author, therefore, after an interval of 80 years repeats his calculation. He obtains exactly the same result. He also obtains formulæ for a hollow anchor-ring and for the inductance of an anchor-ring when the density of the current varies over the cross-section. With high-frequency currents the current distributes itself so that there is no magnetic force inside the ring. The currents left in the ring after the abolition of the primary current must be such that the magnetic force due to them is wholly tangential to the surface of the ring. This was pointed out by Maxwell 40 years ago. Applications to hydrodynamical problems are pointed out. [K. Terazawa has previously pointed out the slip in Wien's work, see Abstract No. 1605 (1909). It is corrected by Rosa in the second edition of the "Compendium of Formulæ." Cohen and Bromwich have also verified Rayleigh's formula. The correction, however, is in most practical cases absolutely negligible.] **A. R.**

1579. *On the Use of a Vibration Electrometer in the Wheatstone Bridge.* **H. Greinacher.** (Phys. Zeitschr. 13. pp. 388–389, May 1, 1912. Rev. Électrique, 17. pp. 514–515, June 14, 1912.)—The author finds that the vibration electrometer is specially suitable for Wheatstone bridge measurements where alternating currents are required. Thus, in order to compare two resistances W_1, W_2, an alternator giving 110 volts 50 ∿ was used with the series resistance W. In order to increase the sensitiveness, the ends of the wire bridge were connected to the primary of a transformer whose secondary terminals were put on to the quartz thread and the case of the electrometer respectively. When near the balance-point the sensitiveness could be considerably increased by putting one terminal of the battery B (40 volts) on to the auxiliary conductor H and the other on to the case. Comparisons can be made with certainty to four figures. The author maintains that for many purposes this instrument is more satisfactory than the telephone or the vibration galvanometer, and is specially suitable for the measurement of self-induction or small capacities. **W. C. S. P.**



1580. *New Form of Emanation Electroscope.* **W. Hammer.** (Deutsch. Phys. Gesell., Verh. 14. 18. pp. 670–674, July 15, 1912.)—The principle of the apparatus is that radium emanation is removed from any solution containing Ra by simply shaking. A rod leading from the vessel can be attached to any standard form of electroscope and the ionisation current measured. The instrument thus avoids loss of emanation by transferring. E. M.

1581. *Wattmeter for Feeble Alternating Currents.* **W. Gerlach.** (Phys. Zeitschr. 13. pp. 589–591, July 1, 1912.)—This instrument contains two fine parallel strips or leads to be traversed by the current under test. The heating of these strips is detected by a Paschen thermopile. The exact arrangement is shown by several diagrams, the instrument being a modification of one for detecting radiation [see Abstract No. 1229 (1912)]. E. H. B.

1582. *Electric Time-measurer.* **F. C. Brown.** (Phys. Rev. 34. pp. 452–458, June, 1912.)—Describes a method of measuring small intervals of time by a ballistic galvanometer, battery, resistances, condenser and contact keys. The principle is based on the relation between the electromagnetic and electrostatic system of units. [See Abstract No. 1566 (1911).] E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

1583. *Magnetic and Elastic Properties of Iron-Carbon Alloys.* **C. W. Waggoner.** (Phys. Rev. 35. pp. 58–65, July, 1912.)—Tests were carried out on eight iron-carbon alloys having carbon-contents ranging up to 1·87 per cent., and all having been annealed at 1000° C. The investigations, which are in continuation of previous work [see Abstract No. 1617 (1909)] showed that the max. hysteresis loss and minimum saturation intensity occurred at 1·1 per cent. carbon, that is to say, near the eutectic point of the series. The writer attempts to account for these facts by the higher magnetic quality of ferrite than of cementite, and by an assumed greater resistance to rotational movement of the magnetic molecules in the intimate pearlitic mixture. He finds also that the saturation intensity of magnetisation and the max. susceptibility show the same variation with the carbon-content as does the ductility of these steels. Further, the max. percentage elongation due to magnetostriction in the steels seems to be a function of the ductility, and may possibly be explained on a basis of the elastic properties of the microscopic constituents comprising these steels. A. D. R.

1584. *The Constant in Frölich's Equation.* **J. R. Ashworth.** (Electrician, 69. p. 709, Aug. 2, 1912.)—Frölich's equation of the relation of field (H) to intensity (I) may be written : $H = PI/(1 - I)$, where I is the fraction of the max. intensity and P is an empirical constant. This equation applies to curves of I and H when hysteresis is suppressed, either by the introduction of an air-gap in the magnetic circuit, or, as Gerosa and Finzi showed, by running an alternating current through the magnetic material. Curves of I and H, constructed by the author under the latter conditions for temperatures up to 700° C., show that the constant P is inversely proportional to the absolute temperature, and that the factor of proportionality plays the part of the reciprocal of Curie's constant A in the paramagnetic equation. G. E. A.

1585. *Causes of Terrestrial Magnetism.* **A. Schuster.** (Phys. Soc., Proc. 24. pp. 121–137, April, 1912.)—No theory of terrestrial magnetism is proposed, but various possible explanations are discussed. The first point is whether the near coincidence of the geographical with the magnetic axis is to be regarded as accidental or significant. The secular variation argues for the second alternative, and scientific opinion has in general favoured this view. The possibility of iron masses being causative of the observed magnetic field has often been dismissed because of the fact that iron loses its magnetisation at temperatures lower than those pertaining to moderate depths below the earth's surface. It is possible, however, that the critical temperature of iron may be raised by pressure. Experiments on this point have been in progress of late years, but are as yet indecisive. Another possible cause is the existence of electric currents circulating inside the earth, but the difficulty of accounting for their original production is apparently a deadlock. Rotation of the earth is next considered; one of the difficulties of accepting this is that the iron in laboratories does not become magnetised to the same extent as that in the earth's crust. The paper concludes with the inquiry whether the negative electron is subject to gravitation. C. P. B.

1586. *The Magneton Theory: A Reply to Heydweiller.* **R. Gans.** (Deutsch Phys. Gesell., Verh. 14. 6. pp. 367–370, March 30, 1912.)—Deals with some points in Heydweiller's criticism [Ibid. 13. 23. pp. 1063–1064, Dec. 15, 1911] of Weiss's magneton theory, with the former of which Gans is not in agreement. L. H. W.

RADIOLOGY AND ELECTROPHYSIOLOGY.

1587. *Ropiquet Transformers: Cooling by Air-currents.* **Nogier** and **Regaud.** (Archives d'Él. Médicale, 20. pp. 196–203, Aug. 25, 1912.)—The transformers in general use for radiographic work all decrease in output with the time, when run continuously for a long period: this is owing to the development of heat. An instance showing in detail the progress of decay in the case of a transformer of 40 cm. spark is given. The new transformer of Ropiquet is kept cool by a rapid circulation of air between the primary and secondary coils. In the complete apparatus this is accomplished with the aid of a blower which comes into action automatically on the temperature reaching 55° C. Even without this auxiliary the convection currents produced are able to keep the temperature well below 60° C. even with a continuous run of 2 hours. It is claimed that these transformers are able to give, without any signs of fatigue, an output of 35–40 amps. for instantaneous work, and a mean of 5–6 amps. for work extending over several hours. A. E. G.

1588. *Vital Effects of Radium and other Rays.* **J. M. Davidson.** (Chem. News, 106. pp. 30–32, July 19; 38–40, July 26, and pp. 50–52, Aug. 2, 1912. Discourse delivered before the Royal Inst.)—A general survey from the medical standpoint.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1589. *Crystallisation of Carbon Dioxide, Nitrous Oxide, and Ammonia.* **H. E. Behnken.** (Phys. Rev. 35. pp. 66–78, July, 1912.)—A method for studying the crystallisation of CO_2 was worked out and then extended to nitrous oxide and ammonia. The method consisted of allowing the gas to crystallise upon a glass plate, which was cooled by liquid air, and then observing the crystals with a microscope, or photographing them with a suitable camera. The crystallisation plate was cooled by enclosing it in a Dewar vessel containing liquid air and was illuminated by an arc lamp, the light being directed by means of a system of lenses, mirrors and a prism. The whole of the crystallisation apparatus was kept out of contact with the external air. The greatest difficulty encountered was the elimination of moisture from the gases, even P_2O_5 failing to remove every trace of moisture under the conditions of the experiments. When the CO_2 was allowed to crystallise slowly, so as to avoid a "snowstorm" it was found that they were isometric and that they were combinations of cubes and octahedra. The crystalline forms of nitrous oxide and ammonia were not determined, owing to the tendency to form coral-like masses, or to form snow. F. J. B.

1590. *The "Paragon" Electron Furnace.* **J. Härdén.** (Faraday Soc., Trans. 7. pp. 183–188; Discussion and Communication, pp. 188–194, June, 1912.)—The furnace combines heating by arcs (suspended carbon-electrodes for three-phase circuits) and resistance heating (3 side-wall electrodes, conductors of the second class) in parallel circuits. The arcs can be used for melting down a cold charge, and the resistance heating has also been sufficient in experiments to melt down a cold charge and to superheat fused metal. H. B.

1591. *Oxidation of Atmospheric Nitrogen in Presence of Ozone.* **T. M. Lowry.** (Chem. Soc., Journ. 101. pp. 1152–1158, June, 1912.)—Resumption of experiments on the Leetham and Cramp process of bleaching flour by ozone [see Abstract No. 154 (1907)]. Air is passed in series through an Andreoli ozoniser and six or more pairs of iron studs serving as spark-gaps. The spectroscopic examination of the very diluted gases is made in a wooden trunk, 64 ft. in length, in which chemically-prepared NO_2 (used as comparison standard) could be detected when present at 1/3500 concentration. Used alone, neither the ozoniser nor three spark-gaps produced any NO_2; and when both discharges were applied, no matter in which order, NO_2 was generated, while ready-made NO_2 was completely bleached by passing through the machine; NO_2 again appeared when the two discharges were coupled in parallel and the resulting two air-currents were afterwards mixed. This indicated that the phenomenon was essentially chemical and not electrical, and the conclusion is drawn that the ozone oxidises, not any nitric oxide formed, but an active modification of nitrogen produced by the spark discharge, as studied by Strutt. H. B.

1592. *Thermal Expansion of Aluminium-Zinc Alloys.* **W. Smirnoff.** Comptes Rendus, 155. pp. 351–352, July 29, 1912.)—Determination of the thermal expansion of Al-Zn alloys between 25° and 270° C. gives results in accord with those of thermal analysis, and micrography, and confirms the existence of a definite compound Al_2Zn_3. W. H. SI.

1593. *Mechanical Hardening and Annealing of Zinc.* **G. Timoféef.** (Comptes Rendus, 155. pp. 480–482, Aug. 12, 1912.)—The author has studied the effect of mechanical hardening and subsequent annealing on the microstructure of zinc. Etching was effected in very dilute nitric acid containing a little chromic acid. Very slow recovery was found to take place at ordinary temperatures, while at 65° C. the recrystallisation effect was very apparent after a few minutes. The change then increased rapidly with the temperature and for the same time of heating the size of the grains increased rapidly with the temperature. Annealed specimens submitted to local deformation and subsequently annealed at a lower temperature than that of the original annealing, showed that while the effect of the deformation was removed, the size of the undeformed grains was not disturbed. F. C. A. H. L.

1594. *Effect of Quenching on the Electrical Resistance of Bronzes and Brasses.* **A. Portevin.** (Comptes Rendus, 155. pp. 459–460, Aug. 19, 1912.)—The increase of resistance of steels and aluminium bronze brought about by quenching is attributed to the retention of the constituents of the eutectoid in solid solution. Since brasses and bronzes also contain eutectoids it appeared to be of interest to determine if a modification of the electrical resistance of these materials could be brought about by quenching from above the eutectoid temperature. Bronzes containing 10 to 20 % Sn showed a distinct increase in resistance when quenched from 650° C. A brass containing 49·8 % Zn and 0·18 % Fe showed an increased resistance after quenching from 550° C. but a still greater increase after quenching from 750° C. This second increase was apparently due to the solution of the small quantity of the γ constituent existing in the original alloy.

F. C. A. H. L.

1595. *Notes on the Investigation of Fractures.* **F. Rogers.** (Iron and Steel Inst., Journ. 85. pp. 379–386; Discussion and Correspondence, pp. 387–389, 1912. Mech. Eng. 29. pp. 748–750, June 14, 1912. Abstract. Engineering, 94. pp. 102–103, July 19, 1912.)—The author has applied a modification of the "sulphur print" process to the study of fractures. A silver-bromide gelatine emulsion is spread on a plastic support consisting of a mixture of whiting, wax, and vaseline. The "tissue" is soaked in a dilute solution of sulphuric acid and alum and pressed into contact with the clean fracture, removed, washed (fixing is optional), and examined. Comparison with sulphur prints from polished faces show that fractured surfaces print more rapidly. The method forms a simple and rapid test of whether a fracture has been assisted by segregation or not. F. C. A. H. L.

1596. *Molecular Conductivities of Potassium Nitrite, Mercuric Nitrite, and Potassium-Mercurinitrite.* **P. C. Rây** and **N. Dhar.** (Chem. Soc., Journ. 101. pp. 965–968, June, 1912.)—There is a reduction of conductivity in solutions containing both mercury and potassium nitrites. This reduction, which is most marked in concentrated solutions, is attributed to the formation of small quantities of a double nitrite—

$$2KNO_2 + Hg(NO_2)_2 \rightleftarrows 2KNO_2, Hg(NO_2)_2.$$ T. M. L.

1597. *Solubility of Calcium Carbonate in Water.* **J. Kendall.** (Phil. Mag. 23. pp. 958–976, June, 1912.)—The solubility of calcium carbonate in water was measured by the direct evaporation of volumes of 2 to 8 litres—a method which was only rendered possible by using silica vessels. The following values were obtained :—

	25°.	50°.	100°.
Calcite	0·01433	0·01504	0·01779 gm./litre
„ (Kohlrausch) ...	0·014	0·016	—
Aragonite	0·01528	0·01617	0·01902
„ (Kohlrausch)	0·016	0·018	—
Calcite (in contact with atmosphere	0·0408	0·02925	0·01779

T. M. L.

1598. *A Constant Carbon-combustion Cell.* **F. Fischer** and **R. Lepsius.** (Phys. Zeitschr. 13. pp. 774–775, Aug. 15, 1912.)—For demonstration purposes the authors recommend a cell of the Bechterew type [see Abstract No. 1632 (1911)]. The crucible (of iron or nickel) itself is not an electrode. The electrodes are lowered into the fused caustic soda, and consist, the one of carbon and the other of magnetic iron oxide, as supplied by the Chemische Fabrik Griesheim-Elektron for the electrolysis of alkali chloride. H. B.

1599. *Variation of E.M.F. with Displacement of the Electrodes.* **St. Procopiu.** (Annal. Scientifiques de l'Univ. de Jassy, 7. pp. 224–234, July, 1912.)—The author noticed that the e.m.f. of an electrolytic valve varied when the Al electrode was shifted, and he studied this phenomenon in concentration cells (containing sulphates of Zn, Cu, Al) and in Daniell cells. The e.m.f. rises to a maximum when the positive electrode (concentrated solution) is displaced, and does not change on further movement; it falls when the negative electrode (diluted solution) is moved, and assumes its former value afterwards in about 10 minutes or more. The changes are of the order of a few hundredths or thousandths of a volt. The changes are not due to any detachment of gas from the electrodes, nor to temperature fluctuations produced by the movement: the cause seems to be that the electrolyte surrounding the ions is impoverished in ions; calculations are made. [Compare Abstract No. 1412 (1911).] H. B.

1600. *Potentials of Zinc in Alcoholic Solutions of Zinc Chloride.* **F. H. Getman** and **V. L. Gibbons.** (Amer. Chem. Journ. 48. pp. 124–138, Aug., 1912.)—The electrical conductivities of solutions of zinc chloride in water are normal while those in alcoholic solutions give evidence of association of the solute and of complex formation between solute and solvent. The more concentrated solutions in methyl alcohol have negative temperature coefficients. Molecular-weight determinations by the boiling-point method showed that in both alcohols zinc chloride is associated, the association in methyl alcohol being greater than in ethyl alcohol. The potentials of zinc in aqueous and alcoholic solutions of zinc chloride were determined by measuring the e.m.f. of the combination Zn-Sol. $ZnCl_2$-Calomel Electrode, and deducting $0·56 + 0·0006t$ for the potential of the calomel electrode. The electrode potential of Zn in aqueous solutions follows Nernst's law in concentrated solutions, but in dilute solutions the experimental values are much smaller than the calculated. The potentials in methyl alcohol oscillate over a range of more than 10 millivolts. Zinc in ethyl alcohol gives with decreasing concentration a uniformly diminishing potential, this behaviour being the reverse of that in aqueous solutions. T. M. L.

1601. *Corrosion of Nickel, Chromium, and Nickel-Chromium Steels.* **J. N. Friend, J. L. Bentley, and W. West.** (Iron and Steel Inst., Journ. 85. pp. 249–258, 1912. Engineering, 93. pp. 753–754, May 31, 1912.)—Mild steels, nickel steels, chrome steels, and nickel-chrome steels have been subjected to corrosion tests in tap-water, sea-water, 0·05 % and 0·5 % sulphuric acid and to alternate wet and dry corrosion tests for periods of from 52 to 64 days. The results show that accelerated tests with dilute acids are liable to give very misleading results as regards general corrodibility owing to the acid increasing the galvanic effect. Nickel steels resist both acid and neutral corrosion, the resistivity increasing with the Ni-content. In chrome steels there appears to be a max. resistivity at a certain Cr-content. The effect of adding both Ni and Cr to steel is not strictly additive, *i.e.*, steels containing 3·72 % Ni and 1·12 % Cr corrode at approximately the same rate, but the effect of the simultaneous presence of both elements is not the same as the effect of double the Cr or Ni percentage. Further experiments are being made for prolonged periods at different temperatures. F. C. A. H. L.

1602. *Polarisation of Electrodes.* **A. Brochet.** (Comptes Rendus, 155. pp. 340–343, July 29, 1912.)—The author uses the method previously employed for plotting the equipotential lines in an electrolyte [see Abstract No. 419 (1912)] to demonstrate the effect of polarisation at the electrodes. No electrode exists which is truly unpolarisable, and this is shown in the case of the copper coulombmeter as follows :—If the distance between the two parallel electrodes is divided into ten parts by nine lines of equipotential, the distances between the lines nearest the electrodes and the electrodes themselves is less than that between the other lines, owing to the existence of polarisation. Moreover, the distances at the anode and kathode are different from each other, showing that the polarisations are different. The asymmetry thus brought about is further shown to exist in the case of bipolar electrodes inserted between the anode and kathode, the diagram for the equipotential lines in a copper coulombmeter in which a bipolar copper electrode is inserted in a direction perpendicular to the electrodes being given.

T. S. P.

1603. *Influence of Carbon on the Corrodibility of Iron.* **C. Chappell.** (Iron and Steel Inst., Journ. 85. pp. 270–293 ; Discussion and Correspondence, pp. 294–296, 1912. Engineering, 93. pp. 854–857, June 21, 1912.)—Gives the results of investigations as to the nature and extent of the influence of increasing percentages of carbon on the corrodibility of iron. Suitable bars of practically pure carbon steels were subjected to typical heat treatments, and their relative corrodibilities determined in each of the various states produced by such treatment. The polished specimens were examined after 91 days immersion in sea-water, and were then reimmersed for a further period of 75 days. The following are the chief conclusions arrived at as a result of this work : 1. *Influence of Carbon on Corrodibility.*—(*a*) In rolled, normalised, and annealed sheets, the corrodibility rises with carbon-content to a maximum at saturation-point (0·89 per cent. C) and falls with increase of C beyond this point. (*b*) In quenched and tempered steels a continuous rise of corrodibility occurs with increase of carbon up to 0·27 per cent. C, no maximum corrodibility at saturation-point being found in these steels. 2. *Influence of Treatment on Corrodibility.*—Quenching increases the corrodibility to a maximum ; annealing tends to reduce it to a minimum ; normalising gives intermediate values. The influence of tempering varies with the tempering temperature.

3. *Factors determining Corrodibility.*—The e.m.f.'s between the ferrite and the pearlite and between the components of the pearlite itself are the principal factors determining the corrodibility of unsaturated pearlitic steels above 0·4 per cent. C. In mild structural steels this galvanic action is accompanied by a further galvanic action between the ferrite crystals themselves, due to differences in their orientation. The state of division of the pearlite and the presence of internal stresses in the steel may exert some influence on the foregoing factors. 4. *Influence of Time on Corrodibility.*—The influence of time on the rate of corrosion varies with different steels. In a low-carbon steel it is found to be practically directly proportional to the length of time of immersion. 5. The influence of corrosion on the resistance offered by a low-carbon steel to alternating stress is not appreciable within a period of 5 months' immersion. 6. Three per cent. of tungsten produces no change in the corrodibility of carbon steels. 7. Decarbonisation increases the resistance to corrosion. 8. The two oxides, FeO and Fe_3O_4, both exert a microscopical pitting effect on steel when in contact with it in sea-water. C. O. B.

1604. *Influence of Physical Condition of the Metals on Kathode Over-voltage.* **J. N. Pring** and **J. R. Curzon.** (Faraday Soc., Trans. 7. pp. 237–243; Discussion, pp. 243–244, June, 1912.)—The anode was in all cases a polished Pt plate, the electrolyte decinormal sulphuric acid at room temperature. The kathodes, copper, zinc, nickel, iron were applied in the annealed or hardened condition, drawn to wires (in the factory) or covered with electro-deposits of the respective metal, the deposits not being submitted to any subsequent treatment. The liberation of hydrogen on the kathode was found to be decidedly dependent on the physical condition of the metal; but there was no general concordance between hardness and over-voltage. Copper, for example, gave the highest over-voltage when hard, iron the lowest over-voltage in that condition; electrolytic coatings raised the over-voltage to its maximum in the case of copper, and lowered it to the minimum in the case of iron and nickel. H. B.

1605. *Radio-active Methods in Electrochemistry.* **G. v. Hevesy.** (Phys. Zeitschr. 13. pp. 715–719, Aug. 1, 1912.)—The author first discusses the results given in Abstract No. 1132 (1912), where it is shown that when a metal plate is dipped into a solution containing RaB and RaC (or ThB and ThC) the relative amounts of the products deposited on the plate depend on its electrochemical potential with regard to the solution. According to Nernst's theory, if a copper plate is dipped into pure water containing no Cu-ions, the potential drop between the copper and the water should at first be infinite (negative), decreasing quickly in absolute value as the copper ions go into solution. In the present paper measurements are given which show experimental evidence in favour of this. If a copper plate is dipped for 0·2 sec. into a solution containing Ra (B + C), the percentage of RaB to RaC deposited on the plate is found to correspond to an electrochemical potential less than $\varepsilon_{Hg} = -1\cdot9$ volts, *i.e.* less than that of Mg. If the copper plate is dipped for 10 sec. the apparent potential determined in this way is about $\varepsilon_{Hg} = -0\cdot7$ volt. With longer periods of exposure to the solution the potential, as determined by the ratio of RaB to RaC, approaches the limit $\varepsilon_{Hg} = 0\cdot0$ volts which is the ordinary electrochemical potential of copper. E. M.